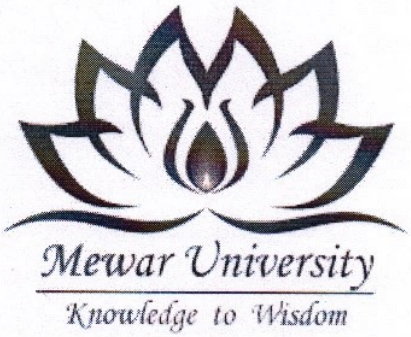

Course Outcomes, Programme Outcomes & Programme Specific Outcomes
of
Bachelor of Technology
Civil Engineering

Mewar University
Knowledge to Wisdom

Course Outcomes of Bachelor of Technology (Civil Engineering)

S. NO	Course Code	Course Title	Course Outcomes
THIRD SEMESTER			
1.	BSC-107	MATHEMATICS-III	CO-1: Demonstrate a comprehensive understanding of advanced mathematical concepts and techniques relevant to civil engineering. CO-2: Evaluate mathematical models and equations to compute and solve complex engineering problems in the field of civil engineering. CO-3: Design mathematical algorithms and computational models to simulate and solve engineering problems in civil engineering applications. CO-4: Develop mathematical strategies and methods to optimize designs and solutions in various areas of civil engineering. CO-5: Apply mathematical principles and techniques to determine critical parameters and make informed decisions in civil engineering projects and applications.
2.	BSC-108	BIOLOGY FOR ENGINEERS	CO-1: Demonstrate a fundamental understanding of basic biological concepts and principles relevant to engineering applications, including cell structure and function, genetics, evolution, and ecology. CO-2: Evaluate the impact of biological processes and systems on engineering projects and designs, such as the role of microorganisms in environmental engineering, bioremediation, and wastewater treatment. CO-3: Design and develop sustainable engineering solutions by applying biological principles, such as bio-inspired designs, biomaterials, and biotechnological applications in the field of civil engineering. CO-4: Compute and analyze biological data, such as population growth rates, species diversity indices, and ecological parameters, to assess the environmental impact of engineering activities and propose mitigation measures. CO-5: Determine the ethical and social implications of biological technologies in engineering practices, including genetic engineering, bioethics, and biopolicy, and apply responsible decision-making strategies in related projects and research.
3.	PCC-CE 201	INTRODUCTION TO	CO-1: Demonstrate understanding of the concept of stress and

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

		SOLID MECHANICS	strain, including simple stresses and strains, St. Venant's principle, elasticity and plasticity, types of stresses and strains, Hooke's law, stress-strain diagram for mild steel, working stress, factor of safety, lateral strain, Poisson's ratio, and volumetric strain. CO-2: Evaluate the relationship between elastic moduli and their significance in engineering applications, such as bars of varying section, composite bars, and temperature stresses. CO-3: Design and analyze the bending moment (BM) and shear force (SF) diagrams for different beam configurations, including cantilevers, simply supported and fixed beams with or without overhangs. Compute maximum BM and SF, determine the point of contraflexure, and calculate the effects of concentrated loads, uniformly distributed loads, uniformly varying loads, and moments. CO-4: Apply the torsion equation and its assumptions to analyze the behavior of hollow and solid circular shafts, including torsional rigidity. Determine the principal stress and maximum shear stresses under combined loading of bending and torsion. CO-5: Develop an understanding of the analysis and design of close-coiled-helical springs, including their applications and the computation of their properties.
4.	**PCC-CE 202**	**ENGINEERING GEOLOGY**	CO-1: Demonstrate an understanding of the branches of geology relevant to civil engineering and the scope of geological studies in various civil engineering projects. Evaluate the roles and scope of organizations such as the Geological Survey of India (GSI), Granite Dimension Stone Cell, and the National Institute of Rock Mechanics (NIRM) in India. CO-2: Evaluate the mineralogy of rocks, including the origin and composition of minerals. Assess the physical properties of minerals and their susceptibility to alteration. Apply the basic principles of optical mineralogy, scanning electron microscopy (SEM), and X-ray diffraction (XRD) for mineral identification. CO-3: Design and examine the petrology of rocks, including rock forming processes, specific gravity of rocks, ternary diagrams, and the classification of igneous, sedimentary, and metamorphic rocks. Evaluate volcanic phenomena, types of volcanic eruptions, and the characteristics of different types of magma. Analyze the formation, chemical and mineralogical composition, and textures of various rock types. CO-4: Develop an understanding of the physical geology aspects relevant to civil engineering, including weathering, erosion,

			denudation, and the geotechnical importance of superficial deposits. Evaluate the behavior of rocks under stress and strain, rock deformation, tectonics, structural elements, and consequences of failure such as landslides, earthquakes, and subsidence. CO-5: Apply the principles of rock mechanics, including the engineering characteristics of rock masses, subsurface investigations, laboratory tests, stress deformation, failure theories, shear strength, and bearing capacity of rocks. Design and determine the suitable geological conditions for dam and reservoir sites, considering factors such as geological considerations, structural features, discontinuities, and treatment of structures.
5.	**PCC-CE 203**	**INTRODUCTION TO FLUID MECHANICS**	CO-1: Demonstrate understanding of basic concepts and definitions in fluid mechanics, including the distinction between a fluid and a solid, density, specific weight, specific gravity, kinematic and dynamic viscosity, variation of viscosity with temperature, Newton's law of viscosity, vapor pressure, boiling point, cavitations, surface tension, capillarity, bulk modulus of elasticity, and compressibility. CO-2: Evaluate fluid statics, including fluid pressure, Pascal's law, and pressure variation with temperature, density, and altitude. Apply various pressure measurement devices such as piezometers, U-tube manometers, single column manometers, U-tube differential manometers, micro manometers, and pressure gauges. Analyze hydrostatic pressure and force on horizontal, vertical, and inclined surfaces. Assess buoyancy and stability of floating bodies. CO-3: Apply concepts such as streamlines, path lines, streak lines, stream tubes, stream function, and velocity potential function. Formulate one, two, and three-dimensional continuity equations in Cartesian coordinates. Evaluate fluid kinematics, including the classification of fluid flow, steady and unsteady flow, uniform and non-uniform flow, laminar and turbulent flow, rotational and irrotational flow, compressible and incompressible flow, ideal and real fluid flow, and one, two, and three-dimensional flows. CO-4: Design fluid dynamics problems by considering surface and body forces. Apply Euler's equation, derive Bernoulli's equation, and understand the energy principle. Evaluate the practical applications of Bernoulli's equation, including venturi meters, orifice meters, and pitot tubes. Apply the momentum principle and analyze forces exerted by fluid flow on pipe bends. Understand vortex flow, both free and forced. Apply dimensional analysis and dynamic similitude by defining

Head
Department of
Civil Engineering
Mewar University, Gangrar

			Reynolds number, Froude number, Mach number, Weber number, and Euler number. Utilize Buckingham's π-Theorem. CO-5: Determine the appropriate use of fluid mechanics principles in engineering applications. Evaluate and compute various parameters, such as density, viscosity, pressure, and velocity, to analyze fluid flow behavior and solve practical problems. Apply the derived equations, principles, and concepts to design and develop solutions for real-world fluid mechanics scenarios.
6.	**PCC-CE 204**	**SURVEYING AND GEOMATICS**	CO-1: Demonstrate an understanding of the principles and methods of surveying, including linear, angular, and graphical techniques. Apply surveying stations and lines, ranging, bearing of survey lines, and principles of levelling for plane table surveying. Compute and reduce levels, perform differential and reciprocal levelling, and conduct profile levelling and cross sectioning. Utilize digital and auto levels, and evaluate errors in levelling. Apply contouring techniques, analyze characteristics and methods, and calculate areas and volumes. CO-2: Evaluate the concepts and techniques of triangulation and trilateration in surveying. Use theodolite instruments for the measurement of horizontal and vertical angles. Apply horizontal and vertical control methods, including triangulation networks and baseline choices. Determine the necessary instruments and accessories for baseline extension, and analyze corrections. Assess trigonometric levelling, inter-visibility of height and distances, and axis single corrections. CO-3: Design and analyze the elements of curves, including simple and compound curves, reverse curves, and transition curves. Apply methods for setting out curves and determine the length of curves. Evaluate the elements of vertical curves and analyze their characteristics. CO-4: Evaluate the modern field survey systems, including electronic distance measurement (EDM) principles, modulation, and types of EDM instruments. Assess the use of distomat and total station instruments, including their parts, accessories, advantages, and applications. Apply field procedures for total station surveying and evaluate errors in total station surveying. CO-5: Evaluate the principles and techniques of photogrammetric surveying. Understand the concepts of perspective geometry of aerial photographs, relief and tilt displacements, terrestrial photogrammetry, and flight planning. Apply stereoscopy, ground control extension for photographic mapping, aerial triangulation, and mapping techniques using

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			paper prints and stereo plotting instruments. Analyze mosaics and map substitutes. Assess remote sensing principles, the electromagnetic spectrum, data acquisition platforms and sensors, visual image interpretation, and digital image processing. Understand the segments of global positioning systems (GPS), GPS measurements, errors and biases, surveying with GPS, coordinate transformation, and accuracy considerations.
7.	**HSMC201**	**Organizational Behavior**	CO-1: Determine the fundamental principles and concepts of organizational behavior in the context of the cement and ceramics industry. Evaluate the impact of organizational behavior on individual and group behavior within organizations. Demonstrate an understanding of the theoretical foundations of organizational behavior. CO-2: Apply organizational behavior theories and concepts to analyze and evaluate real-world case studies and scenarios in the cement and ceramics industry. Assess the effectiveness of various organizational behavior strategies and interventions in improving employee performance, job satisfaction, and organizational outcomes. CO-3: Develop an understanding of the impact of leadership styles and behaviors on organizational behavior and performance. Design and evaluate leadership strategies that align with the unique challenges and dynamics of the cement and ceramics industry. Apply effective leadership practices to enhance employee motivation, engagement, and productivity. CO-4: Compute and analyze the factors influencing individual and group decision-making processes within organizations. Evaluate the role of communication, power, and conflict management in organizational behavior. Design and implement strategies to promote effective communication, manage power dynamics, and resolve conflicts in the cement and ceramics industry. CO-5: Design and develop strategies for managing organizational change and innovation in the cement and ceramics industry. Evaluate the factors that influence organizational change, resistance to change, and the implementation of innovative practices. Apply change management theories and techniques to facilitate successful organizational change and foster a culture of innovation.
FOURTH SEMESTER			
8.	**PCC-CE 208**	**MATERIALS, TESTING & EVALUATION**	CO-1: Demonstrate an understanding of engineering materials, including cements, M-Sand, various types of concrete (plain,

			reinforced, steel fiber/glass fiber-reinforced, lightweight, high-performance, polymer), ceramics and refractories, bitumen and asphaltic materials, timbers, glass and plastics, structural steel and other metals, paints and varnishes, acoustical materials, geo-textiles, rubber and asbestos, laminates and adhesives, graphene, carbon composites, and their properties and uses. CO-2: Evaluate the mechanical behaviour and characteristics of engineering materials. Assess the principles and characteristics of elasticity, plastic deformation of metals, tensile test standards for different materials (brittle, quasi-brittle, elastic, etc.), interpretation of true stress-strain from tensile tests, hardness tests, and bending and torsion tests. CO-3: Design and develop an understanding of material testing for ceramics, including the strength of ceramics, internal friction, creep, brittle fracture of steel, fracture mechanics, fracture toughness testing for different materials, fatigue of materials, and procedures for structural integrity assessment. CO-4: Apply standard testing and evaluation procedures for engineering materials. Evaluate mechanical testing methods, naming systems for various irons, steels, and nonferrous metals, elastic deformation, plastic deformation, impact tests, transition temperatures, fracture mechanics, fracture toughness for different materials, and creep behaviour. CO-5: Determine the appropriate laboratory procedures for mechanical testing. Demonstrate knowledge of mechanical testing principles and discuss the procedures involved in conducting tests. Compute and interpret results for mechanical testing, including impact tests, fracture toughness, fatigue behaviour, and creep.
9.	**PCC-CE 209**	**CONSTRUCTION ENGINEERING & MANAGEMENT**	CO-1: Evaluate the stages of construction project planning, including pre-tender planning, pre-construction planning, and detailed construction planning. Assess the roles of clients and contractors in the planning process and determine the appropriate level of detail required. Develop work breakdown structures, activity lists, and assess work content for accurate planning and estimation. CO-2: Design and develop plans and schedules for construction projects. Apply techniques such as bar charts, Gantt charts, and network analysis (CPM and PERT) to represent activities, compute float values, determine critical paths, and calculate probabilities of completion. Demonstrate proficiency in calendaring networks and estimation of durations. CO-3: Apply construction methods and techniques for various aspects of construction projects. Assess different types of

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (

			foundations and construction methods, including formwork and staging. Evaluate common building construction methods, modular construction methods, precast concrete construction methods, slip forming for tall structures, and construction methods for steel structures and bridges. CO-4: Determine the appropriate construction equipment and understand the advantages of mechanized methods. Evaluate equipment for earthmoving, dewatering, concrete mixing, transportation, and lifting. Assess equipment productivities and compare conventional construction methods with mechanized methods. Understand the basics of construction site planning, organization, and resource management. CO-5: Develop skills in project monitoring and control. Understand the importance of supervision, record keeping, and periodic progress reports. Learn to update plans regularly and identify common causes of time and cost overruns. Gain knowledge of modern project management systems such as Lean Construction and Building Information Modeling (BIM). Evaluate quality control measures, safety, health, and environmental considerations on construction sites. Understand contract management basics, including the types of contracts, contract clauses, and dispute resolution methods.
10.	**PCC-CE 210**	**MECHANICS OF MATERIALS**	CO-1: Determine and evaluate finite and infinitesimal deformations in structural elements. Analyze statically determinate trusses and assess the stability of dams, retaining walls, and chimneys. Perform stress analysis of thin, thick, and compound cylinders. Apply deformation and strain concepts to describe the behavior of structural elements accurately. CO-2: Apply the principles of momentum balance and stress analysis to determine forces, moments, shear forces, and bending moments transmitted by slender members. Construct shear force and bending moment diagrams. Evaluate stress states and understand failure criteria for different materials. Analyze the mechanics of deformable bodies under uniaxial loading and consider material properties. Assess the deformation of trusses under static conditions. CO-3: Evaluate and analyze the relationship between displacement and strain, including multiaxial strain and stress-strain relationships. Analyze elastic properties and elasticity bounds, including stress-strain-temperature relationships and thin-walled pressure vessels. Perform stress and strain transformations, determine principal stress, and evaluate the failure of materials. Assess structural stability, particularly the stability of columns, and apply Euler's formula and effective

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			length factor. CO-4: Evaluate the effects of shear and torsion on structural elements. Apply energy and variational methods, including Castigliano's theorem and Maxwell Bettie's reciprocal theorem, for solving deflection problems in beams and frames. CO-5: Apply the principles of strain energy, elastic, complementary, and total strain energy in analyzing axially loaded bars, beams in bending, shear, and torsion. Understand thermoelectricity and its effects on structural elements. Utilize virtual work and unit load methods to determine deflections and apply them to solve problems related to beams and frames. Apply the knowledge gained in real-world applications and engineering design.
11.	**PCC-CE 211**	**HYDRAULIC ENGINEERING**	CO-1: Demonstrate an understanding of laminar and turbulent flow through circular pipes, annulus, and parallel plates. Apply Stoke's law and perform measurements of viscosity. Analyze the transition from laminar to turbulent flow, including the causes, mechanisms, and effects of turbulent flow in pipes. Utilize semi-empirical theories of turbulence, such as Prandtl's mixing length theory, and evaluate resistance to flow in smooth and rough pipes using Moody's diagram. CO-2: Evaluate boundary layer theory and its application in fluid flow analysis. Calculate boundary layer thickness, displacement, momentum thickness, and energy thickness. Analyze laminar and turbulent boundary layers on flat plates, including the concepts of laminar sub-layer and smooth and rough boundaries. Calculate local and average friction coefficients. Understand the phenomenon of separation and methods of control. CO-3: Apply dimensional analysis and hydraulic similitude techniques to fluid flow problems. Utilize dimensional homogeneity, Rayleigh method, Buckingham's Pi method, and other methods to determine dimensionless groups. Conduct model studies and analyze their relevance to fluid flow analysis. Compare open channel flow with pipe flow, evaluate geometrical parameters and classification of open channels, and understand velocity distribution in channel sections. CO-4: Determine factors affecting Manning's roughness coefficient "n" and calculate the most economical section of a channel. Compute uniform flow and normal depth. CO-5: Evaluate and analyze the non-uniform flow, including specific energy, specific energy curve, critical flow, discharge

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			curve, specific force, specific depth, and critical depth. Analyze channel transitions and various methods of discharge and velocity measurement, such as Venturi flume, standing wave flume, Parshall flume, current meter, floats, and hot-wire anemometer. Understand gradually varied flow and its dynamic equation, classification of channel bottom slopes and surface profiles, and computation of water surface profiles using graphical, numerical, and analytical approaches. Study the theory, characteristics, and applications of hydraulic jumps, including energy dissipation and surge effects. Apply the momentum principle in fluid flow analysis, considering forces on plates, pipe bends, and moments of momentum equation.
12.	**PCC-CE 212**	**STRUCTURAL ANALYSIS**	CO-1: Apply Castigliano's theorems and the strain energy method to analyze frames with one or two redundant members. Compute deflections and reactions using Castigliano's 2nd theorem. Utilize slope deflection and moment distribution methods for the analysis of continuous beams, portal frames, and frames with inclined members. Evaluate the effects of user support settlement and determine distribution factors. Apply the methods to beams and frames without side sway, frames with side sway, and those subjected to uneven loading and support settlement. CO-2: Demonstrate an understanding of influence lines and moving loads. Define influence lines and calculate them for statically determinate beams and trusses. Determine maximum reactions, shear, and bending moments using influence lines. Apply Muller Breslau influence theorem for statically determinate beams and trusses. CO-3: Develop bending moment diagrams for various loadings and consider temperature effects, rib shortening, axial thrust, and radial shear force diagrams. Understand the concept of unsymmetrical bending, centroidal principal axes of sections, and calculate bending stresses in beams subjected to unsymmetrical bending. Determine the shear center for channel, angle, and Z sections. CO-4: Apply the concept of elastic center and properties of analogous columns. Use the method to analyze beams and frames. Understand the strain energy method of analysis and its application. Introduce the concept of nature methods of analysis, including the flexibility method and stiffness method. CO-5: Evaluate the design and analysis principles of cable and suspension bridges. Analyze uniformly loaded cables, consider temperature stresses, and study three-hinged and two-hinged stiffening girders in cable bridges and suspension bridges.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

13.	**H-102**	**UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY**	CO-1: Evaluate the principles and concepts of universal human values to develop an understanding of harmony in personal and professional life. CO-2: Apply ethical reasoning and critical thinking skills to analyze and resolve conflicts in order to promote harmony in diverse social and cultural contexts. CO-3: Demonstrate empathy and respect for others' perspectives, beliefs, and values, fostering harmonious relationships in personal and professional interactions. CO-4: Apply effective communication and interpersonal skills to promote understanding, collaboration, and harmony in diverse teams and communities. CO-5: Demonstrate self-awareness and self-reflection to cultivate inner harmony and well-being, contributing to a balanced and harmonious society.
FIFTH SEMESTER			
14.	**PCC-CE 301**	**TRANSPORTATION ENGINEERING**	CO-1: Evaluate the classification of roads and understand the road development scenario in India. Analyze the current road projects in India and their significance in highway development and planning. Demonstrate knowledge of the processes involved in highway alignment and project preparation. CO-2: Apply the principles of geometric design in highways. Understand the elements of highway cross-section and their design considerations. Evaluate sight distance requirements and apply them to design horizontal alignment. Determine the design parameters for vertical alignment. Analyze the design principles for intersections and solve related problems. CO-3: Demonstrate an understanding of traffic engineering and control. Evaluate traffic characteristics and conduct traffic engineering studies. Analyze traffic flow and capacity and understand the principles of traffic regulation and control. Design road intersections and parking facilities, considering traffic requirements. Evaluate the design principles for highway lighting and solve related problems. CO-4: Evaluate the properties and testing requirements for Portland cement and cement concrete used in pavements. Solve problems related to the selection and use of different pavement materials. CO-5: Apply the design principles for pavements. Understand

			the factors affecting the design and performance of flexible pavements. Analyze the stresses in flexible pavements and design them according to the guidelines provided by the Indian Roads Congress (IRC). Evaluate the components and functions of rigid pavements and understand the factors affecting their design and performance. Design concrete pavements as per IRC specifications and solve related problems.
15.	**PCC-CE 302**	**HYDROLGY AND WATER RESOURCES ENGINEERING**	CO-1: Evaluate the fundamental concepts of hydrology, including the hydrologic cycle, water-budget equation, and the history of hydrology. Understand the global water balance and its relevance to engineering applications. Demonstrate knowledge of various data sources used in hydrological analysis. CO-2: Evaluate the rain gauge network and its role in collecting precipitation data. Apply depth-area-duration relationships and intensity-duration-frequency relationships to estimate maximum intensity and probable maximum precipitation. Interpret rainfall data specific to India. CO-3: Evaluate the processes of evaporation and evapotranspiration, including the measurement techniques and estimation methods. Understand the factors influencing evaporation and the reduction methods for reservoir evaporation. Evaluate different types of abstractions from precipitation, such as interception, depression storage, and infiltration. Analyze infiltration capacity, measurement techniques, and infiltration indices. CO-4: Evaluate runoff and its estimation using methods like the SCS-CN method. Understand the flow-duration curve, flow-mass curve, and hydrograph concepts. Analyze the factors affecting runoff hydrographs and the components of a hydrograph. Understand the principles of base flow separation and effective rainfall. Evaluate surface water resources and environmental flows. CO-5: Demonstrate an understanding of groundwater and well hydrology. Assess the characteristics of aquifers and the properties of saturated formations. Analyze the steady-state flow in wells and the equilibrium equations for confined and unconfined aquifers. Understand aquifer tests and their significance. Evaluate the water withdrawals and uses in various sectors such as energy production, agriculture, and flood control. Analyze surface water supply, irrigation water requirements, and irrigation methods. Assess canal systems, including alignment, losses, and design discharge estimation. Understand the design principles for channels, canal outlets, and canal lining. Analyze the causes, effects, and remedial measures

			for water logging.
16.	PCC-CE 303	STRUCTURAL ENGINEERING	CO-1: Demonstrate an understanding of the fundamental concepts of energy principles, safety, and sustainable development in structural performance. Evaluate the factors that contribute to the stability and equilibrium of structures. Explain the roles and responsibilities of structural engineers, architects, users, and builders in the design and construction process. Analyze the functions and objectives of structural engineering. CO-2: Apply the planning and design process in structural engineering. Assess the materials used in structural design and their properties. Evaluate the various loads acting on structures and the importance of design safety. Analyze the behavior and properties of concrete and steel as structural materials. Understand the impact of wind and earthquake loads on structural design. CO-3: Evaluate the criteria and principles for the design of structural systems. Analyze determinate and indeterminate trusses, beams, and frames using appropriate analysis methods. Understand the design philosophies and approaches in structural engineering. Conduct laboratory experiments to analyze determinate and indeterminate structures. CO-4: Apply the design principles to structural elements, including concrete and steel elements. Understand the theories and concepts involved in the design and analysis of concrete and steel structures. Design reinforced concrete beams for flexure, shear, and serviceability. Analyze the behavior of reinforced concrete columns and slabs. Introduce the principles of steel design and analyze tension members, connections, and bending members. Evaluate different structural systems. CO-5: Develop an understanding of system design concepts in structural engineering. Explore special topics relevant to the design project discussions. Analyze cable structures, pre-stressed concrete bridges, and considerations of constructability and structural control. Understand the importance of fire protection in structural design.
17.	PCC-CE 304	ENVIRONMENTAL ENGINEERING	CO-1: Demonstrate knowledge and understanding of various sources of water, including their quality issues, and the water quality requirements for different beneficial uses. CO-2: Evaluate and analyze water quality standards, water quality indices, and water safety plans to ensure the provision of safe and clean water for consumption and other purposes.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (R

			CO-3: Design and develop effective water supply systems, including the planning and implementation of planned water supply schemes, considering the water demand for industrial, agricultural, and domestic purposes. CO-4: Compute and apply the principles of water treatment, such as aeration, sedimentation, coagulation flocculation, filtration, disinfection, and advanced treatments like adsorption, ion exchange, and membrane processes, to improve water quality. CO-5: Determine appropriate measures for sewage and storm water management, including the design of sewerage systems, sewage pumping, conveyance of sewage, storm water quantification and design, and wastewater treatment methods, while considering the quality requirements for various purposes and environmental impact.
18.	**PEC-CE 301**	**DESIGN OF CONCRETE STRUCTURES-I**	CO-1: Demonstrate knowledge and understanding of material strength and properties, including the grades of concrete and steel, characteristic strength, and working strength, to evaluate the suitability of materials for structural design. CO-2: Evaluate and compare the design methodologies of the Working Stress Method and Limit State Method in the design of reinforced concrete (RC) sections, considering principles, assumptions, partial safety factors, and their advantages. CO-3: Design and develop RC sections, including beams, slabs, columns, and tension members, using both the Working Stress Method and Limit State Method, with an emphasis on the latter. This includes determining moment of resistance, bond, flexural and anchorage bonds, development length, and detailing requirements. CO-4: Compute and apply the principles of design and detailing for retaining walls, including classification, forces, stability requirements, and proportioning of cantilever and counter-fort retaining walls. Design examples should be provided to demonstrate the application of these principles. CO-5: Determine appropriate design criteria and develop design solutions for various types of RC structures, such as simply supported, cantilever, and continuous beams, as well as one-way and two-way slabs, considering relevant IS Code coefficients and guidelines.
19.	**PEC-CE 302**	**CONSTRUCTION ENGINEERING MATERIALS**	CO-1: Demonstrate knowledge and understanding of the classification, requirements, and querying of stones, bricks, tiles, terra cotta, lime, cement, steel, timber, paints, and polymeric

Head
Department of
Civil Engineering
Rawal University, Chittorgarh (R

			materials, in order to evaluate their suitability for construction purposes. CO-2: Evaluate and test various construction materials, such as bricks, tiles, lime, cement, timber, and paints, to determine their quality and compliance with standards and specifications. CO-3: Design and develop appropriate mix designs for concrete, considering factors affecting workability, durability, strength, and acceptance criteria, and conduct physical tests to ensure the desired properties of the concrete. CO-4: Compute and apply the principles of masonry construction, including the selection of appropriate materials, tools, bonds, and construction techniques for brickwork, stone masonry, and non-bearing partition walls. CO-5: Determine and apply appropriate construction techniques and materials for various building components, such as roofs, floors, doors, windows, and finishing works, including plastering, painting, damp proofing, and termite treatment, while considering their functional requirements and aesthetic aspects.
20.	**PEC-CE 303**	**SOLID AND HAZARDOUS WASTE MANAGEMENT**	CO-1: Demonstrate knowledge and understanding of the types and sources of solid and hazardous wastes, including the need for effective management, and the key elements of solid waste management systems. CO-2: Evaluate and analyze waste generation rates, composition, and the physical, chemical, and biological properties of solid wastes, including hazardous characteristics, in order to develop strategies for source reduction, recycling, and reuse. CO-3: Design and develop efficient systems for the handling, segregation, storage, and collection of municipal solid wastes, as well as the storage, labeling, and handling of hazardous wastes, considering compatibility, analysis of collection systems, and compliance with relevant regulations and standards. CO-4: Compute and apply the methods and technologies for waste processing, including material separation, composting, incineration, solidification, and stabilization of hazardous wastes, while ensuring effective controls and adherence to environmental guidelines. CO-5: Determine appropriate waste disposal options, such as land filling, and apply the principles of landfill classification, site selection, design, and operation of sanitary landfills, with a focus on secure and environmentally sound practices for waste disposal.
21.	**PEC-CE 304**	**RURAL WATER SUPPLY AND ONSITE SANITATION SYSTEMS**	CO-1: Demonstrate knowledge and understanding of the attributes of water supply systems in rural areas, including the importance of drinking water quality and its relationship to diseases, hygiene, and sanitation.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (R

			CO-2: Evaluate and analyze the need for water treatment in rural areas, and design point-of-use water treatment systems, such as filters (including bio-sand filters), disinfection systems (including chlorination and solar disinfection), and removal techniques for contaminants like arsenic, fluoride, and iron. CO-3: Design and develop onsite sanitation systems in rural areas, considering the nexus between water quality and sanitation, as well as the importance of hydrogeology in the selection of appropriate systems. This includes the design of septic tanks, single pit and double pit toilets, ensuring proper functionality and environmental sustainability. CO-4: Design small bore systems, such as bio digesters, reed beds, constructed wetlands, and sludge/seepage management systems, for efficient and environmentally friendly treatment of wastewater in rural areas. CO-5: Determine appropriate strategies and technologies for managing and maintaining rural water supply and onsite sanitation systems, considering factors such as cost-effectiveness, scalability, and community participation, to ensure sustainable access to safe drinking water and proper sanitation practices.
22.	**PEC-CE 305**	**CONTRACTS MANAGEMENT**	CO-1: Demonstrate knowledge and understanding of the importance of contracts in construction projects and the fundamentals of contract management, including the overview of activities and the parties involved in contract management. CO-2: Evaluate and analyze the different types of contracts and their formation, considering the rights and duties of various parties, contract duration, price, and performance parameters. This includes an understanding of common contract clauses and the legal framework governing contracts. CO-3: Design and develop effective contract administration and payment processes, including managing relationships with contractors, handling delays, penalties, and liquidated damages, addressing force majeure and suspension issues, and handling changes and variations in contracts. This also includes knowledge of conventional and alternative dispute resolution methods. CO-4: Develop strategies for managing risks and change in contract management, including identifying and mitigating risks, managing change requests, and ensuring integrity in contract management. Understand the process of contract closure and

			post-implementation review. CO-5: Apply monitoring and measurement techniques to manage the performance of contracts, including monitoring contract deliverables, evaluating performance against set parameters, and taking appropriate actions to ensure successful contract outcomes. Understand the legal aspects related to contract management, including dispute resolution and the legal view of contract management.
	HSMC-301 (OEL II)	**HUMANITIES I (EFFECTIVE TECHNICAL COMMUNICATION)**	CO-1: Demonstrate effective written communication skills by composing clear and concise technical documents related to civil engineering. Apply appropriate grammar, punctuation, and formatting conventions in written reports, memos, and other professional documents. CO-2: Demonstrate present technical information verbally with clarity and confidence. Deliver well-structured and organized presentations using appropriate visual aids and communication techniques. Engage the audience effectively and respond to questions and feedback. CO-3: Apply active listening skills to understand and interpret technical information accurately. Demonstrate the ability to extract relevant information from oral and written sources, such as technical manuals, research papers, and engineering specifications. CO-4: Evaluate and synthesize technical information from multiple sources to generate comprehensive and well-reasoned reports. Apply critical thinking skills to evaluate data, draw conclusions, and make recommendations based on technical information. CO-5: Demonstrate effective teamwork and collaboration skills in the context of technical communication. Participate actively in group discussions, provide constructive feedback to peers, and contribute to the development of collaborative technical documents and presentations.
23.	**PROJ- CE 301**	**Minor Project/ Seminar/Summer Internship**	CO-1: Demonstrate effective project management skills, including planning, organizing, and executing the project. Manage time, resources, and tasks efficiently to meet project milestones and deadlines. Collaborate and communicate effectively with project stakeholders. CO-2: Apply theoretical knowledge and practical skills acquired during the course of the B. Tech Civil Engineering program to address the problem or explore the chosen topic in the context of the minor project/seminar/summer internship.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			CO-3: Apply engineering principles, theories, and concepts to analyze and solve real-world problems encountered during the minor project, seminar, or summer internship. CO-4: Demonstrate effective communication skills by presenting project findings or internship experiences through written reports, oral presentations, and visual aids. CO-5: Evaluate the outcomes and impact of the minor project, seminar, or summer internship in terms of enhancing technical knowledge, developing practical skills, and gaining professional experience in the field of civil engineering. Reflect on personal growth and identify areas for further improvement.
SIXTH SEMESTER			
24.	**PCC-CE 307**	**DISASTER PREPAREDNESS & PLANNING MANAGEMENT**	CO-1: Demonstrate knowledge and understanding of the fundamental concepts and definitions related to disasters, hazards, vulnerability, and risks. This includes an understanding of the severity, frequency, and details of risks, as well as the capacity and impact of disasters. Evaluate prevention and mitigation strategies. CO-2: Evaluate and analyze different types of disasters, including natural disasters (floods, droughts, cyclones, earthquakes, etc.) and manmade disasters (industrial pollution, chemical spills, terrorist strikes, etc.). Assess the hazard and vulnerability profile of India, with a focus on mountain and coastal areas and ecological fragility. CO-3: Evaluate the impacts of disasters on various aspects, such as the environment, physical structures, social systems, ecological balance, economy, politics, and health. Analyze demographic aspects and special needs considerations. Assess global and national disaster trends, as well as the influence of climate change on urban disasters. CO-4: Design and develop disaster risk reduction (DRR) strategies and understand the various phases of the disaster management cycle, including prevention, mitigation, preparedness, relief, and recovery. Assess both structural and non-structural measures for risk reduction, conduct risk analysis and vulnerability assessments, and understand the importance of early warning systems. Evaluate post-disaster environmental response and the roles and responsibilities of government, communities, NGOs, and other stakeholders in DRR. CO-5: Develop the interconnections between disasters, the

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (R

			environment, and development. Assess the factors affecting vulnerability, such as the impact of developmental projects and environmental modifications. Evaluate sustainable and environmentally friendly approaches to recovery, reconstruction, and development in the aftermath of disasters. Understand the policies, legislation, and DRR programs in India, including the activities of the National Disaster Management Authority.
25.	**PCC-CE 308**	**GEOTECHNICAL ENGINEERING**	CO-1: Demonstrate knowledge and understanding of the types of soils, their formation, and deposition. Differentiate between soil mechanics, soil engineering, rock mechanics, and geotechnical engineering. Evaluate the scope of soil engineering and compare soil with rock. Apply basic definitions and relationships related to soil mechanics, such as weight, volume, voids ratio, porosity, moisture content, unit weights, degree of saturation, and specific gravity. CO-2: Determine various parameters of soil, including moisture content, specific gravity, and unit weight, using different methods such as oven dry method, pycnometer method, and sand-replacement method. Apply the relationships between volume, weight, voids ratio, moisture content, unit weight, percent air voids, saturation, and specific gravity. CO-3: Determine the plasticity characteristics of soil, including consistency limits, flow and toughness indices, activity, and sensitivity. Determine the liquid limit, plastic limit, and shrinkage limit of soils. Classify soils based on particle size, textural classification, unified soil classification system, and Indian standard soil classification system. Identify soils based on their general characteristics in different groups. CO-4: Determine the coefficient of permeability of soils using laboratory methods like the constant-head method and falling-head method, as well as field methods like pumping-in and pumping-out tests. Analyze the permeability aspects of stratified soils and factors affecting permeability. Perform seepage analysis using Darcy's law, stream and potential functions, and graphical methods to plot flow nets. CO-5: Evaluate and analyze the concept of effective stress and its principles, including the nature of effective stress, the effect of the water table, fluctuations of effective stress, and seepage pressure. Evaluate the compaction of soils, including the theory of compaction, laboratory determination of optimum moisture content and maximum dry density, compaction in the field, compaction specifications, and field control.
26.	**PCC-CE 309**	**ENGINEERING**	CO-1: Demonstrate a comprehensive understanding of the basic

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (R

		ECONOMICS, ESTIMATION & COSTING	principles and methodology of economics, including concepts of demand, supply, elasticity, government policies, and their application. Evaluate the theory of the firm and market structure. Analyze macroeconomic concepts such as GDP, GNP, NI, and disposable income for both closed and open economies. Understand the concepts of aggregate demand and supply, price indices, interest rates, and direct and indirect taxes. CO-2: Evaluate the concepts of welfare and externalities in public sector economics. Analyze the labour market and its implications. Understand the components of the monetary and financial system, including the role of the central bank, monetary aggregates, commercial banks, and their functions, as well as capital and debt markets. Evaluate the tools of monetary and fiscal policy and their impact on the economy, including inflation and the Phillips Curve. CO-3: Apply the principles of business and managerial economics, including different forms of organizations. Analyze costs and cost control techniques, types of costs, lifecycle costs, budgets, break-even analysis, and capital budgeting. Evaluate investment analysis using techniques such as NPV, ROI, IRR, payback period, depreciation, and time value of money. Apply elementary techniques of business forecasting. Use case study methods to analyze real-world economic scenarios. CO-4: Apply estimation and measurement techniques in the field of civil engineering, including the process of estimation, use of Indian Standard Specifications, quantity take-offs, bar bending schedules, mass haul diagrams, and estimating various construction elements such as earthwork, foundations, concrete, masonry, finishes, and MEP works. Understand the use of Building Information Modelling (BIM) and computer applications in quantity surveying. Understand the importance and types of specifications and perform rate analysis for different construction tasks. CO-5: Develop skills in tender preparation, including the creation of tender documents, inviting tenders, understanding contract types, general and special conditions, contract termination, extra work and changes, penalties, liquidated damages, and dispute settlement. Understand the processes of preparing RA (Running Account) bills and final bills, payment procedures, insurance, claims, price variation, and bidding. Familiarize with relevant acts related to minimum wages, workman's compensation, contracts, arbitration, and easement rights.
27.	**PEC-CE 306**	**BRIDGE ENGINEERING**	CO-1: Demonstrate a comprehensive understanding of the stages involved in bridge investigation, including classification of bridges and the necessary investigations and estimates. Evaluate the importance of topographic details, catchment area maps, hydrologic particulars, geotechnical details, seismology,

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			navigation requirements, construction resources, and traffic forecasts in bridge investigation. Apply the knowledge to prepare project reports and drawings. CO-2: Evaluate the loading standards and requirements for bridge structures, including railway and road bridge loadings. Understand the process of setting out piers, abutments, single-span bridges, and multi-span bridges. Analyze the construction techniques for open excavation, foundations below the water table, pile foundations (including precast and cast-in-situ piles), and load tests on piles, well foundations, and sinking of wells. Understand the construction of superstructures. CO-3: Design concrete bridges for road transport, including simply supported solid slab bridges and girder bridges. Apply dispersion of load along the span, design principles for slabs, longitudinal girders, deck slabs, and Courbon's method. Evaluate the design of bearings for concrete bridges. Analyze the design principles for steel bridges, particularly steel girders used in railway bridges. CO-4: Evaluate and analyze the necessity of bridge inspection and the procedures involved. Evaluate different aspects of bridge inspection and the testing methods used. Assess the safe load-bearing capacity of bridges. Analyze the maintenance requirements for bridge substructures, superstructures, bearings, and girders. Apply appropriate maintenance techniques for ensuring the longevity and safety of bridges. CO-5: Apply the principles of techno-economic feasibility in the selection of ideal bridge sites. Understand the significance of project report preparation and the role of estimates in bridge investigation. Demonstrate the ability to prepare drawings and documents required for bridge construction projects.
28.	**PEC-CE 307**	**RAILWAY ENGINEERING**	CO-1: Demonstrate a comprehensive understanding of the main requirements and component parts of railway permanent way. Evaluate the functions and requirements of rails, including weight, length, and qualities of a good rail. Identify and analyze defects in rails. Assess the importance of rail joints and other fastenings, check rails, guard rails, coning of wheels, and rail creep. Apply this knowledge to ensure the safe and efficient functioning of railway tracks. CO-2: Evaluate the types of sleepers used in railway engineering, considering their functions, requirements, and density. Analyze the importance of ballast in railway tracks, including its functions and requirements. Compare and contrast different types of ballast materials used. Apply this knowledge to design and construct a reliable and stable railway track.

			CO-3: Design and calculate the geometric parameters of railway tracks, focusing on horizontal curves, super elevation, negative super elevation in branches, length of transition curves, grade compensation on curves, and widening of gauge on curves. Apply these design principles to ensure smooth and safe train operations on curved sections of railway tracks. CO-4: Develop the design features of turnouts and the types of railway track points. Analyze the details of station yards and marshalling yards in railway operations. Evaluate the principles of signaling, interlocking, track circuiting, and train control systems such as absolute block systems, automatic block systems, and centralized traffic control systems. Apply this knowledge to ensure efficient and safe train movements in railway networks. CO-5: Apply the knowledge of maintenance practices to ensure the reliability and longevity of railways, including high-speed trains. The design and layout of track junctions and simple track configurations. Analyze the importance of track maintenance, including track drainage, modern methods of track maintenance, and rehabilitation and renewal of track. Evaluate the factors affecting tractive resistance and power in railway operations. Understand the principles and techniques of railway tunneling.
29.	**PEC-CE 308**	**INTELLIGENT TRANSPORTATION SYSTEMS**	CO-1: Demonstrate an understanding of the fundamental concepts of Intelligent Transportation Systems (ITS) and identify the objectives of ITS. Evaluate the historical background and benefits of ITS in improving transportation efficiency, safety, and sustainability. Apply this knowledge to assess the potential of ITS in addressing transportation challenges. CO-2: Evaluate the data collection techniques used in ITS, including detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), and video data collection. Analyze the importance of accurate and reliable data for effective ITS implementation. Apply these techniques to collect and analyze transportation data for various ITS applications. CO-3: Evaluate the role of telecommunications in ITS and its significance in information management and traffic management centers (TMC). Evaluate the concepts of vehicle-roadside communication and vehicle positioning systems. Analyze the different functional areas of ITS, such as Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations

Head
Department of
Civil Engineering
Mewar University Chittorgarh (Ra

			(CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), and Advanced Rural Transportation Systems (ARTS). CO-4: Evaluate the user needs and services provided by ITS, including travel and traffic management, public transportation management, electronic payment systems, commercial vehicle operations, emergency management, advanced vehicle safety systems, and information management. Analyze the benefits and challenges associated with these ITS services. CO-5: Compute the concept of Automated Highway Systems and the integration of vehicles in platoons. Evaluate the implementation of ITS programs in developed countries and the challenges and opportunities for ITS in developing countries. Assess the potential of ITS in improving transportation systems worldwide and promoting sustainable and efficient mobility solutions.
30.	**PEC-CE 309**	**PORT AND HARBOUR ENGINEERING**	CO-1: Demonstrate an understanding of the principles and concepts of port and harbor engineering, including the design and development of port facilities, coastal engineering, and navigation systems. CO-2: Evaluate the environmental and socio-economic impacts of port and harbor projects, considering factors such as sedimentation, erosion, water quality, and community well-being. Assess the sustainability and feasibility of proposed port and harbor developments. CO-3: Design and compute the layout and configuration of port and harbor structures, such as breakwaters, jetties, piers, wharves, and berthing facilities. Apply appropriate design principles to ensure stability, durability, and functionality of these structures. CO-4: Develop comprehensive plans for port and harbor infrastructure, considering factors such as vessel traffic, cargo handling requirements, navigation channels, and access roads. Design efficient and safe traffic management systems within the port area. CO-5: Determine the optimal dredging requirements for port and harbor operations, including the computation of dredged volumes, sediment transport, and disposal methods. Apply knowledge of dredging techniques and equipment to ensure navigable channels and sufficient water depths for vessels.
31.	**PEC-CE 310**	**HYDRAULIC**	CO-1: Demonstrate an understanding of the basics of hydraulic

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

		MODELLING	modeling, including similarity mechanics, model laws, and the distinction between numerical and hydraulic models. Evaluate the classification of hydraulic modeling and the materials used in model construction. Apply scale effects to design, construct, operate, and interpret the results of hydraulic models. CO-2: Evaluate the role of instrumentation and data processing in hydraulic modeling. Analyze the modeling techniques for gravity-dominated scenarios, including the modeling of energy dissipaters, overflow spillways, siphon spillways, bridge piers, vortex formation, cavitations, and flow-induced vibrations. Demonstrate the ability to apply these techniques to real-world hydraulic problems. CO-3: Evaluate the modeling techniques for gravity friction scenarios, such as pumped flow models, ship models, and surge tank models. Analyze the modeling techniques for friction-dominated scenarios and river models with fixed and mobile beds. Demonstrate an understanding of basin and reservoir models and tidal models with fixed and mobile beds. Apply these modeling techniques to simulate real-world hydraulic systems. CO-4: Develop the modeling techniques for harbor and breakwater structures, as well as offshore structures. Evaluate the concepts of hybrid and analogue models and their application in hydraulic modeling. Assess the scope and limitations of hydraulic modeling and understand the complementary aspects of numerical and hydraulic modeling. Demonstrate the ability to select appropriate modeling approaches based on the problem at hand. CO-5: Apply critical thinking skills to assess the strengths and weaknesses of hydraulic modeling techniques. Evaluate the reliability and accuracy of hydraulic models in representing real-world hydraulic phenomena. Demonstrate the ability to interpret and communicate the results of hydraulic models effectively.
32.	**OEC 301**	**SOFT SKILL & INTERPERSONAL COMMUNICATION**	CO-1: Apply effective verbal and non-verbal communication skills to convey information clearly and professionally in various interpersonal and professional settings. CO-2: Demonstrate active listening skills to understand and interpret information accurately in conversations, meetings, and presentations. CO-3: Develop effective presentation and public speaking skills to deliver clear, engaging, and persuasive presentations to

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			diverse audiences. CO-4: Apply critical thinking and problem-solving skills in interpersonal communication to resolve conflicts, negotiate, and collaborate effectively in a team or group setting. CO-5: Demonstrate proficiency in written communication by preparing well-structured, coherent, and professional reports, emails, and other written documents relevant to civil engineering practice.
33.	**MC-II**	**ESSENCE OF INDIAN KNOWLEDGE TRADITION**	CO-1: Demonstrate a comprehensive understanding of the essence of Indian knowledge tradition, including its philosophical, cultural, and scientific aspects, and its relevance to the field of civil engineering. CO-2: Evaluate the impact of Indian knowledge tradition on sustainable development, environmental consciousness, and ethical practices in civil engineering projects and designs. CO-3: Design engineering solutions that integrate principles from Indian knowledge tradition, such as Vastu Shastra and traditional construction techniques, to enhance the functionality, aesthetics, and energy efficiency of built environments. CO-4: Develop an appreciation for the holistic approach of Indian knowledge tradition in addressing engineering challenges by considering social, economic, and ecological aspects of project planning and execution. CO-5: Apply the principles of Indian knowledge tradition to determine culturally appropriate and context-specific engineering solutions that are aligned with the values, beliefs, and needs of the local community.
34.	**PROJ-CE 302**	**PROJECT-II (Major Project)**	CO-1: Design and develop a comprehensive project plan for a major civil engineering project. This includes identifying the project objectives, scope, and deliverables, as well as creating a detailed timeline and resource allocation plan. CO-2: Apply engineering principles and theoretical knowledge to conduct a thorough analysis and evaluation of the project requirements. This involves identifying the project constraints, conducting feasibility studies, and considering environmental, economic, and social factors. CO-3: Demonstrate the ability to effectively communicate and collaborate with team members, stakeholders, and clients throughout the project lifecycle. This includes presenting project

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			proposals, progress reports, and final deliverables in a clear and professional manner. CO-4: Apply project management techniques and tools to efficiently monitor and control the project progress. This involves creating work breakdown structures, managing project risks, tracking project milestones, and making necessary adjustments to ensure project objectives are met within the allocated resources and time frame. CO-5: Evaluate and critically analyze the project outcomes and results. This includes conducting technical assessments, performing quality control measures, and assessing the overall success of the project in meeting its intended goals and objectives.
SEVENTH SEMESTER			
35.	**PEC-CE 401**	**DESIGN OF CONCRETE STRUCTURES-II**	CO-1: Evaluate the basic assumptions and principles of continuous beams. Demonstrate an understanding of moment of inertia, settlements, and the modification of moments in continuous beams. Apply appropriate analysis techniques to determine maximum moments and shear forces in continuous beams. Modify moments and shear forces for beams curved in plan. Apply torsion analysis to beam structures. Apply moment redistribution techniques for single and multi-span beams. Design continuous beams using relevant design examples. CO-2: Design flat slabs considering openings. Design various types of staircases using appropriate design principles. Apply design examples to reinforce the understanding of flat slabs and staircases. CO-3: Evaluate the design requirements for water tanks, silos, and bunkers. Estimate wind and earthquake forces on these structures. Design rectangular and cylindrical underground and overhead tanks, including Intze tanks. Apply design considerations specific to water tanks. Analyze and design silos and bunkers, considering different theories and configurations. Apply design examples to reinforce the understanding of water tanks, silos, and bunkers. CO-4: Demonstrate an understanding of the basic principles and classification of prestressed concrete members. Evaluate various prestressing systems and the associated losses in prestress. Analyze and design prestressed sections for flexure and shear, considering the concepts of load balancing and relevant IS specifications. Apply design examples to reinforce the

			understanding of prestressed concrete design. CO-5: Evaluate the yield line theory and its basic assumptions. Apply different methods of analysis to determine yield line patterns and failure mechanisms in one-way and two-way rectangular and non-rectangular slabs. Analyze the effect of top corner steel in square slabs. Apply design examples to reinforce the understanding of yield line theory. Assess the design principles and considerations for foundations, including combined footings, raft foundations, and pile caps. Design pile foundations, including under-reamed piles, using appropriate design principles. Apply design examples to reinforce the understanding of foundation design.
36.	**PEC-CE 402**	**FOUNDATION ENGINEERING**	CO-1: Evaluate the types of shallow foundations and their relative merits. Apply the knowledge of foundation depth and footing on slopes to determine appropriate foundation designs. Determine uplift of footings and apply the conventional procedure of proportioning footings. Demonstrate an understanding of combined footings, raft foundations, and floating foundations. Apply the principles of bearing capacity to analyze the behavior of raft foundations in sands and clays. Apply various methods of designing rafts and floating foundations. CO-2: Apply design criteria for ensuring structural safety of foundations, including the location of footings, shear failure criterion, and settlement criterion. Evaluate the factors influencing ultimate bearing capacity and the modes of shear failure. Analyze Rankine's analysis, Terzaghi's theory, Skempton's formula, and the effects of fluctuation of the groundwater table and eccentricity on bearing capacity. Interpret the results of plate load tests and analyze bearing capacity based on penetration tests. Apply design methods to determine the bearing capacity of shallow foundations. CO-3: Evaluate the necessity of pile foundations and classify different types of piles. Analyze the load capacity of piles through static and dynamic analysis. Interpret pile load tests and analyze negative skin friction. Determine lateral load capacity and uplift capacity of single piles. Assess the behavior of piles in group action and analyze pile spacing and pile group capacity. Apply settlement analysis and design pile caps. CO-4: Evaluate the stability of slopes and the causes of failure. Determine factors of safety and perform stability analysis of slopes using total stress analysis and effective stress analysis. Analyze the stability of infinite slopes and different types of failures of finite slopes. Apply analysis methods such as the mass

			procedure and the method of slices. Consider the effects of pore pressure and utilize Fellinius method and friction circle method to locate critical slip circles. Assess the slope stability of earth dams during steady seepage, sudden drawdown, and construction phases. CO-5: Apply critical thinking skills to assess the strengths and weaknesses of different foundation types and design approaches. Evaluate the factors influencing foundation behavior and stability. Analyze the reliability and safety of foundation designs based on various criteria. Demonstrate the ability to interpret and communicate foundation design principles effectively.
37.	**PEC-CE 403**	**STRUCTURAL DYNAMICS**	CO-1: Evaluate the fundamental objective of structural dynamic analysis and classify types of prescribed loadings. Demonstrate an understanding of the essential characteristics of a dynamic problem and apply the method of discretization. Apply the lumped mass procedure to analyze dynamic systems. Analyze the behavior of single degree of freedom systems and determine generalized displacements. CO-2: Analyze generalized single degree of freedom systems and express their properties mathematically. Solve the equation of motion for undamped and damped free vibrations. Determine critical damping, under damped systems, over damped systems, and the concept of Coulomb damping. CO-3: Analyze the response of structures to harmonic loading. Evaluate undamped systems and determine complementary solutions, particular solutions, and general solutions. Calculate response ratios and analyze viscously damped systems. Assess resonant response and dynamic amplification factors. Evaluate the concept of vibration isolation. Analyze the response of structures to periodic loading using Fourier series expressions. CO-4: Evaluate the behavior of multi-storey shear buildings using lumped mass modeling and analyze modes of vibration. Understand the performance of buildings and structures under earthquakes, including causes of damage, intensity of earthquake forces, lack of strength and integrity, quasi-resonance, lack of ductility, lack of detailing, and assessment of damage. CO-5: Apply critical thinking skills to evaluate the principles and concepts of structural dynamics. Analyze the effects of earthquakes on buildings, structures, power plants, switchyards, and other lifeline structures. Assess soil liquefaction and its impact on structural behavior. Demonstrate an understanding of

			the assessment of damage caused by earthquakes. Communicate the principles and concepts of structural dynamics effectively.
38.	**PEC-CE 404**	**ROCK MECHANICS**	CO-1: Demonstrate an understanding of the relationship between rock mechanics, soil mechanics, and engineering geology. Apply the principles of rock mechanics to civil engineering problems. Classify rocks based on lithology and engineering properties. Apply classification systems such as RQD, RMR, and Q systems to categorize rock masses. CO-2: Evaluate the properties of rocks through laboratory tests, including compression, tensile, void index, permeability, and shear tests. Analyze the effects of specimen size, rate of testing, and confining pressure on rock behavior. Interpret stress-strain curves of typical rocks. Determine the strength of intact and fissured rocks. Assess the influence of anisotropy, saturation, and temperature on rock properties. Analyze the shear strength of jointed rock masses. CO-3: Apply field tests, such as uniaxial tests, shear tests, and pressure tunnel tests, to evaluate the behavior of rocks in tunnels and open excavations. Analyze the stability of rock slopes, including failure modes, plane wedge analysis, 3D wedge analysis, circular modes of failure, and back analysis of slopes. Use stability charts and design rock bolts for slope stabilization. Determine in-situ stresses in rocks using methods such as hydraulic fracturing, flat jack tests, and over coring. CO-4: Design tunnels using rock pressure theories, ground reaction curves, and rock support interaction analysis. Apply empirical and semi-empirical methods for tunnel analysis. Design tunnel linings and understand their types. Evaluate the foundation of rocks by analyzing stress distribution, determining the bearing capacity of rocks, and implementing methods to improve rock properties. Apply pressure grouting, dental concreting, and shear zone treatment techniques. CO-5: Apply critical thinking skills to assess the principles and concepts of rock mechanics. Evaluate the suitability of rock masses for civil engineering projects. Analyze the behavior of rocks under various loading and environmental conditions. Design and recommend appropriate engineering measures for rock-related challenges. Communicate the principles and concepts of rock mechanics effectively.
39.	**PEC-CE 405**	**TRAFFIC ENGINEERING AND MANAGEMENT**	CO-1: Demonstrate an understanding of general travel forecasting principles and the different methods of traffic forecast, including mechanical and analytical methods. Evaluate demand relationships and apply methods for future traffic

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			projection. Analyze the concept of design vehicle units and determine Passenger Car Units (PCU) under mixed traffic conditions. Apply price-volume relationships and demand functions to determine design hourly volume. Apply the critical hour concept in traffic forecasting. CO-2: Evaluate factors affecting highway capacity and level of service. Conduct capacity studies for various highway facilities, including unsignalized and signalized intersections. Analyze problems related to mixed traffic flow. Use case studies to assess the capacity of different highway facilities and intersections. CO-3: Analyze individual accidents and statistical data to conduct accident analysis. Represent accident rates using appropriate methods. Evaluate the factors influencing traffic accidents and the impact of roadway and traffic conditions on traffic safety. Calculate accident coefficients and assess driver strains caused by roadway and traffic conditions. CO-4: Evaluate and analyze the fundamental flow relationships in traffic flow theory and their practical applications. Apply traffic flow theories to analyze traffic behavior. Analyze shock waves and queuing theory in the context of traffic flow. Evaluate probabilistic aspects of traffic flow, including vehicle arrivals, distribution models, gaps, and headway distribution models. Assess gap acceptance merging parameters, delay models, and their applications. Apply simulation techniques in traffic engineering, formulate simulation models, and analyze, case studies. CO-5: Apply critical thinking skills to analyze and evaluate traffic flow, capacity, and safety issues. Design and develop effective traffic forecasting models. Apply appropriate methods and techniques to address traffic flow challenges. Apply simulation tools to assess and optimize traffic systems. Communicate the findings and recommendations of traffic analysis and forecasting effectively.
40.	**MC III**	**CONSTITUTION OF INDIA**	CO-1: Evaluate the fundamental principles and provisions of the Constitution of India, including the Preamble, fundamental rights, and directive principles of state policy. Apply critical analysis to understand the constitutional framework and its relevance to civil engineering practices. CO-2: Evaluate the structure and organization of the Indian government, including the executive, legislative, and judicial branches. Evaluate the separation of powers and checks and balances within the Indian constitutional system.

			CO-3: Demonstrate an understanding of the fundamental rights guaranteed by the Constitution of India and their significance in promoting social justice, equality, and inclusivity. Evaluate the role of fundamental rights in protecting civil liberties and promoting individual freedoms. CO-4: Evaluate the constitutional provisions related to the protection and conservation of the environment, sustainable development, and the promotion of ecological balance. Evaluate the impact of these provisions on civil engineering practices and infrastructure development. CO-5: Apply legal and constitutional principles to analyze and address contemporary issues and challenges related to governance, public administration, and the rule of law in India. Develop a critical perspective on constitutional amendments and legal reforms impacting civil engineering projects and policies.
41.	**PROJ-CE 401**	**SHORT TERM TRAINING (21-45 Days) / PROJECT-III**	CO-1: Apply theoretical knowledge and practical skills acquired during the short-term training to solve real-world civil engineering problems effectively. CO-2: Demonstrate the ability to work collaboratively in a team environment during the short-term training, effectively contributing to group projects and activities. CO-3: Evaluate and analyze different techniques, tools, and methodologies learned during the short-term training to enhance efficiency and productivity in civil engineering practices. CO-4: Demonstrate proficiency in using industry-standard software and equipment relevant to civil engineering, acquired through hands-on training and practical exercises. Communicate technical concepts, ideas, and findings effectively through written reports, presentations, and discussions, showcasing the knowledge and skills gained during the short-term training.
EIGHTH SEMESTER			
42.	**PROJ-CE 402**	**Industrial Internship/Project-IV**	CO-1: Apply engineering principles and techniques learned during the academic program to solve real-world problems encountered during the industrial internship. CO2: Demonstrate effective communication and interpersonal skills while working in a professional setting, collaborating with colleagues, and interacting with clients and stakeholders.

			CO-3: Evaluate and analyze industry-specific processes, practices, and technologies relevant to civil engineering, and identify areas for improvement or optimization. CO-4: Demonstrate the ability to adapt to a professional work environment, understand and adhere to organizational policies and procedures, and exhibit professionalism, ethics, and integrity. Acquire practical knowledge and hands-on experience in executing civil engineering projects, utilizing industry-standard tools, techniques, and software applications. CO-5: Develop skills in project management, problem-solving, and decision-making within the context of real-world engineering projects.

Head
Department of
Civil Engineering
Meyar University, Chittorgarh (Raj.)

Mewar University
Knowledge to Wisdom

Programme Outcomes (POs): of Bachelor of Technology (Civil Engineering)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Head
Department of
Civil Engineering
Mewar University
Chittorgarh (Raj.)

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Head
Department of
Civil Engineering
Chittorgarh (Raj.)

Programme Specific Outcomes (PSO's) of Bachelor of Technology (Civil Engineering)

PSO1: Able to understand, design, and analyze the structural Engineering for real-world engineering problems.

PSO2: Able to comprehend the technological advancements in construction material and provide design solutions for the benefit of society.

PSO3: Able to apply software programming skills and provide design solutions for transportation, environmental, structural-enabled services.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar University

Knowledge to Wisdom

Course Outcomes, Programme Outcomes & Programme Specific Outcomes
of
Master of Technology
Environmental Engineering

Mewar University
Knowledge to Wisdom

Course Outcomes of Master of Technology (Environmental Engineering)

S.NO	Course Code	Course Title	Course Outcomes
FIRST SEMESTER			
1	EVE-611	Environmental Chemistry and Microbiology	CO-1: Demonstrate an understanding of the fundamental principles and basic concepts of environmental chemistry, including the composition of the environment, stratospheric chemistry, tropospheric chemistry, atmospheric aerosols, and the chemistry of greenhouse gases. CO-2: Evaluate the impact of environmental chemistry on global climate and the atmosphere, including the formation of ozone, the formation of smog and precipitation, and the role of atmospheric aerosols in climate change. CO-3: Design and develop strategies for addressing environmental issues related to aqueous organic matter, water pollution, and wastewater treatment chemistry, considering the removal and remediation of pollutants from water sources. CO-4: Compute and apply knowledge of the chemistry of solid wastes to assess the environmental implications and develop appropriate waste management strategies, including waste reduction, recycling, and disposal techniques. CO-5: Determine the role of microorganisms in environmental processes, including their involvement in sewage treatment, bio-remediation, bio-leaching, metal extraction, detection of environmental pollution through biosensors, and the generation of biological fuels
2	EVE -612	Air and Noise Pollution	CO-1: Demonstrate an understanding of air pollution by defining key terms, describing the composition of the atmosphere, explaining the origin of air pollution, identifying different sources of air pollutants, and classifying air pollutants based on their characteristics and effects. CO-2: Evaluate the meteorological aspects of air pollution by analyzing the dispersion of air pollutants, predicting plume behaviours, utilizing air diffusion models, designing stacks for efficient pollutant dispersion, and assessing the impact of air pollution on meteorological conditions. CO-3: Design and develop sampling techniques for air pollution assessment by selecting appropriate methods for ambient and stack sampling, conducting ambient air quality monitoring, and evaluating compliance with air

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			quality standards. CO-4: Compute and apply engineered methods of air pollution control by applying atmospheric cleansing processes, choosing suitable approaches for contaminant control, selecting and designing control devices for particulate and gaseous contaminants, and evaluating their effectiveness. CO-5: Determine strategies for noise pollution control by defining noise pollution and its unit of measurement, understanding the hearing mechanism and loudness perception, conducting noise measurements using weighting networks, identifying sources of noise pollution, assessing the psychological and pathological effects of noise, developing noise monitoring protocols, and evaluating compliance with noise pollution standards
3	**EVE -613**	**Water Treatment Processes**	CO-1: Demonstrate an understanding of water quality parameters and their examination by applying appropriate analytical techniques. CO-2: Evaluate the significance of water quality requirements and standards in ensuring the wholesomeness of water for various uses. CO-3: Design and develop water purification processes in natural systems by integrating physical, chemical, and bio-chemical processes to achieve effective water treatment. CO-4: Compute and apply various water treatment processes, such as aeration, coagulation, filtration, and disinfection, in engineered systems to improve water quality. CO-5: Determine appropriate actions to address specific water quality issues, including the removal of contaminants like fluoride, arsenic, iron, and manganese, and mitigating taste, odor, and corrosion problems in water treatment processes
4	**EVE -614**	**Sustainable Waste Management**	CO-1: Demonstrate an understanding of the concept of sustainability in water and waste management, as well as the importance of environmental indices and bio-remediation techniques. CO-2: Evaluate the different methods and technologies used for water conservation, such as rainwater harvesting and roof water harvesting, considering their quality, health implications, and their role in groundwater recharge. Analyze case studies to assess their effectiveness. CO-3: Design and develop natural wastewater treatment systems by comparing centralized and

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			decentralized approaches. Apply knowledge of natural and constructed wetlands, including their mechanisms, performance, and design considerations. Utilize case studies to determine the suitability and efficiency of these systems. CO-4: Compute and apply low-cost sanitation techniques, including dry sanitation methods, pit latrines, VIP latrines, and septic tanks. Assess their efficacy in providing sanitation solutions in various contexts, considering factors such as cost, maintenance, and environmental impact. CO-5: Determine and take appropriate actions for organic solid waste management by evaluating composting/vermi-composting techniques, biogas technology, and plasma technology. Analyze their effectiveness in managing organic waste, considering factors such as resource recovery, energy generation, and environmental.
5	EVE -615	**Advance Wastewater Treatment**	CO-1: Demonstrate an understanding of wastewater characteristics and their significance. CO-2: Evaluate different methods of determining the biochemical oxygen demand (BOD), nitrification, and organic content in wastewater. CO-3: Design and develop wastewater treatment processes, such as screens, grit chambers, flotation, sedimentation, and zone settling. CO-4: Compute and apply kinetic relationships of bio-kinetic parameters for oxygen transfer and aeration of wastewater, and determine the design procedures for various aeration systems. CO-5: Determine and apply the theory and design principles of physical arrangements, such as ponds, lagoons, rotating biological contactors, sequencing batch reactors, anaerobic and filter UASB systems, and sludge treatment processes including sludge stabilization, digestion, gas production, and disposal. Additionally, evaluate the tertiary treatment methods for nitrogen and phosphorus removal
6	EVE -616	**Environmental Planning and Management**	CO-1: Demonstrate an understanding of environmental and sustainable development principles, including the concept of carrying capacity and its relation to quality of life, resource utilization, and regional planning. CO-2: Evaluate the limitations of carrying capacity-based short and long-term regional planning in engineering methodology, considering factors such as population growth, resource availability, and environmental impacts.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-3: Design and develop socio-economic developmental policies and planning strategies that consider both economic development and social welfare, taking into account the total cost of development and environmental protection costs. CO-4: Compute and apply engineering economic principles, including value engineering, time value of money, cash flows, budgeting, and accounting techniques, to assess the feasibility and cost-effectiveness of cleaner technologies in environmental protection. CO-5: Determine the importance of environmental quality management through the application of total quality management (TQM) and ISO 14000 Series of Standards. Conduct environmental audits to assess and improve environmental management practices
SECOND SEMESTER			
7	**EVE -621**	**Solid and Hazardous Waste Management**	CO-1: Demonstrate an understanding of the definitions, generation, sources, classification, quantity, composition, and characteristics of solid waste. CO-2: Evaluate solid waste collection, transportation, processing, recovery, and disposal methods for their efficiency and environmental impact. CO-3: Design appropriate methods for the recovery of materials from solid waste and select suitable sites for disposal. CO-4: Develop strategies for sanitary land filling, including the methodology for waste disposal, leachate treatment, and gas collection and recirculation. CO-5: Determine the appropriate techniques and parameters for composting, incineration, and pyrolysis processes, considering factors such as temperature control, air pollution prevention, and end product analysis
8	**EVE -622**	**Industrial Waste Management**	CO-1: Determine the characteristics and composition of different industrial effluents, and evaluate their potential environmental impacts upon disposal. CO-2: Apply strategies for the prevention and control of industrial pollution, including the implementation of pollution prevention technologies and compliance with standards for the disposal of industrial effluents. CO-3: Design and develop effective waste management strategies for industrial facilities, utilizing techniques such as good housekeeping, equalization, neutralization, chemical precipitation, and other appropriate methods.

			CO-4: Evaluate and compute the water and energy use in industrial processes, and propose efficient and sustainable practices to minimize resource consumption and environmental impact. CO-5: Design treatment systems for industrial effluents, including the mixing and treatment of combined effluent streams, and develop specific treatment methods for the unique characteristics of industrial effluents from various industries such as sugar, pulp and paper, distilleries, electroplating, dairy, oil refineries, steel, etc.
9	EVE -623	**Environmental Impact Assessment**	CO-1: Demonstrate a comprehensive understanding of the concept, rationale, and purpose of Environmental Impact Assessment (EIA), and its significance in evaluating the potential environmental consequences of development activities and projects. CO-2: Evaluate the benefits and limitations of EIA as a tool for decision-making, including its role in promoting sustainable development and ensuring the integration of environmental concerns in project planning and implementation. CO-3: Design and develop methodologies for measuring and assessing various environmental impacts, such as physical, social, economic, and other variables, using appropriate environmental indices and impact assessment methods. CO-4: Compute and apply suitable impact assessment methodologies to identify, assess, and evaluate the fundamental impacts (e.g., air, noise, water, soil & geological, biotic, socio-economic, and aesthetic) associated with development activities, and propose mitigation measures to minimize adverse effects. CO-5: Determine and propose economic approaches to environmental impact assessment, including the analysis of economic activities and their interactions with the environment, applying techniques such as the social benefit-cost approach, input-output analysis, econometric modelling, and programming approaches.
10	EVE -624	**Life Cycle Analysis and Design for Environment**	CO-1: Demonstrate an understanding of environmental health and safety principles in engineering products and processes. CO-2: Evaluate the environmental impact of various stages in the product life cycle, considering factors such as material toxicity, pollution, and degradation. CO-3: Design environmentally conscious products and manufacturing approaches, applying sustainable development and industrial ecology concepts.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (R

			CO-4: Develop strategies for pollution prevention and select appropriate manufacturing processes, considering trade-offs and environmental considerations. CO-5: Determine the applicability of design for environment principles, guidelines, and tools, and apply them to assess recyclability, re-manufacturability, and life-cycle analysis of products.
11	**EVE -625**	**Industrial safety and environment**	CO-1: Demonstrate an understanding of the quality parameters and classification of natural water, and apply physico-chemical and biological methods to classify aquatic systems. CO-2: Evaluate the sources of pollution in water bodies, including the characteristics of point and non-point sources, and determine the potential impacts on water quality. CO-3: Design and develop strategies to control eutrophication in natural water bodies, considering the causes and processes involved in eutrophication, as well as the appropriate management techniques. CO-4: Compute and apply knowledge of the sources, transport mechanisms, and management strategies for toxic wastes, with an emphasis on protecting water quality and minimizing environmental impacts. CO-5: Determine the causes, model the effects, and design control measures for thermal pollution and acid rains, considering their occurrence, impacts, and various strategies to mitigate their negative effects on water quality
12	**EVE -627**	**Environmental Issues Protection and Laws**	CO-1: Demonstrate an understanding of key environmental issues, including climate change, global warming, stratospheric ozone depletion, acid rains, and their scientific evidence, by explaining their causes, impacts, and interconnections. CO-2: Evaluate the effectiveness of international protocols and conventions related to the protection of the ozone layer, climate, biodiversity, and oceans, by critically analyzing their objectives, mechanisms, and outcomes. CO-3: Design and develop strategies for addressing globalization, sustainability, and climate change, by formulating plans that promote environmentally conscious practices and policies at local, national, and global levels. CO-4: Compute and apply the environment policy of the Government of India, by analyzing its objectives, strategies, and implementation mechanisms, and

			assessing its impact on environmental conservation and sustainable development. CO-5: Determine the implications of environmental legislation and laws in India, including those concerning water pollution, air pollution, industrial pollution, forest conservation, and solid waste disposal, by examining their provisions, enforcement machinery, and judicial trends, and evaluating corporate environmental liability within the legal framework.
THIRD SEMESTER			
13	**EVE -631**	**Renewable Energy Sources**	CO-1: Demonstrate an understanding of key environmental issues, including climate change, global warming, stratospheric ozone depletion, acid rains, and their scientific evidence, by explaining their causes, impacts, and interconnections. CO-2: Evaluate the effectiveness of international protocols and conventions related to the protection of the ozone layer, climate, biodiversity, and oceans, by critically analyzing their objectives, mechanisms, and outcomes. CO-3: Design and develop strategies for addressing globalization, sustainability, and climate change, by formulating plans that promote environmentally conscious practices and policies at local, national, and global levels. CO-4: Compute and apply the environment policy of the Government of India, by analyzing its objectives, strategies, and implementation mechanisms, and assessing its impact on environmental conservation and sustainable development. CO-5: Determine the implications of environmental legislation and laws in India, including those concerning water pollution, air pollution, industrial pollution, forest conservation, and solid waste disposal, by examining their provisions, enforcement machinery, and judicial trends, and evaluating corporate environmental liability within the legal framework
14	**EVE -632**	**Application of Remote Sensing in Environmental Engineering**	CO-1: Demonstrate an understanding of the fundamental concepts and principles of remote sensing and electromagnetic radiation (EMR) in the context of environmental engineering. CO-2: Evaluate the components and energy sources involved in remote sensing, including active and passive remote sensing techniques, and their applications in environmental engineering. CO-3: Design and develop strategies for image interpretation and digital image processing, including the selection and utilization of appropriate equipment,

			keys, and interpretation procedures. CO-4: Compute and apply digital image processing techniques such as rectification, restoration, enhancement, transformation, classification, and analysis to remotely sensed images for environmental engineering purposes. CO-5: Determine the application of remote sensing in environmental engineering through the evaluation ,of case studies, demonstrating knowledge of its role in the management and monitoring of land, air, water pollution, conservation of resources, and coastal zone management
15	**EVE-633**	**Seminar**	CO-1: Demonstrate the ability to critically analyze and evaluate research papers, technical reports, and case studies related to environmental engineering topics. CO-2: Evaluate and compare different environmental engineering technologies and their applicability in solving real-world environmental challenges. CO-3: Design and develop effective seminar presentations that effectively communicate complex environmental engineering concepts to a diverse audience. CO-4: Compute and analyze data related ,to environmental parameters, pollution levels, and environmental impacts using appropriate statistical and computational tools. CO-5: Develop critical thinking and problem-solving skills through active participation in seminar discussions, case studies, and group projects.
16	**EVE-634**	**Minor Project**	CO-1: Demonstrate the ability to identify a research problem related to environmental engineering and propose a suitable minor project topic. CO-2: Evaluate the feasibility of the chosen minor project topic by conducting a thorough literature review and analysis of existing research. CO-3: Design and develop a comprehensive research plan, including experimental methodologies, data collection techniques, and necessary resources for the minor project. CO-4: Compute and analyze data collected during the minor project using appropriate statistical and computational tools to draw meaningful conclusions. Apply theoretical knowledge and practical skills in environmental engineering to implement the minor project effectively.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-5: Evaluate the overall success and effectiveness of the minor project in achieving its objectives and contributing to the field of environmental engineering. Determine future research directions or potential applications based on the findings and outcomes of the minor project, contributing to the advancement of environmental engineering knowledge and practice.
FOURTH SEMESTER			
17	**EVE-641**	**Dissertation**	CO-1: Demonstrate a comprehensive understanding of the research methodology and techniques relevant to environmental engineering. CO-2: Evaluate the existing literature and research in the field of environmental engineering to identify research gaps and opportunities for further investigation. CO-3: Design and develop a research proposal that addresses a significant environmental engineering problem or explores a novel solution. Compute and analyze data collected during the research process using appropriate statistical and computational tools. CO-4: Develop a systematic and structured approach to conducting research, including ethical considerations and adherence to relevant standards and regulations. CO-5: Apply critical thinking and problem-solving skills to interpret research findings and draw valid conclusions.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar university
Faculty of Engineering

Programme Outcomes of Master of Technology (Environmental Engineering)

The Master of Technology (M.Tech) program in Environmental Engineering is designed to provide students with a comprehensive understanding of the principles, concepts, and practices related to environmental engineering. Upon completion of this program, students should be able to demonstrate the following outcomes:

PO-1 Advanced knowledge of structural engineering: Apply knowledge of environmental engineering principles to identify, formulate, and solve complex engineering problems related to the environment.

PO-2 Proficiency in structural analysis and design software: Analyze, design, and develop solutions for sustainable environmental engineering systems, processes, and technologies.

PO-3 Understanding of environmental issues: Evaluate the impact of engineering solutions on the environment, public health, and safety.

PO-4 Effective communication skills: Communicate effectively with stakeholders, including other engineers, policymakers, and the general public; regarding environmental engineering issues.

PO-5 Ethical and professional responsibilities Demonstrate an understanding of the ethical and professional responsibilities of environmental engineers, including issues related to sustainability, social responsibility, and environmental justice.

PO-6 Multidisciplinary Approach Work effectively in multidisciplinary teams to solve complex environmental engineering problems.

PO-7 Proficiency in engineering software: Students should be proficient in the use of engineering software for design, analysis, and simulation of civil engineering systems.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar University
Knowledge to Wisdom

Programme Specific Outcomes (PSO's) of Master of Technology (Environmental Engineering)

PSO1: Able to carry out environmental impact assessments for proposed projects and develop strategies for mitigating environmental impacts.

PSO2: Able to understand, manage and monitoring environmental systems, including pollution control systems, environmental monitoring systems, and waste management systems.

PSO3: Able to carry out research projects and development activities related to environmental engineering and are able to apply the latest tools and techniques to these activities.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Course Outcomes, Programme Outcomes & Programme Specific Outcomes
of
Master of Technology
Structural Engineering

Mewar University
Knowledge to Wisdom

Course Outcomes of Master of Technology (Structural Engineering)

S.NO	Course Code	Course Title	Course Outcomes
FIRST SEMESTER			
1	SE-611	Structural Dynamics	CO-1: Demonstrate an understanding of the fundamental principles and concepts related to static and dynamic analysis, loading, and the essential characteristics of dynamic problems. CO-2: Evaluate and determine the appropriate methods for formulating equations of motion and mathematical modeling of dynamic systems, including single degree of freedom (SDOF) systems and multiple degrees of freedom (MDOF) systems. CO-3: Design and develop solutions for damped and undamped free vibrations in SDOF systems, including the application of viscous and Coulomb's damping, and analyze the response to harmonic excitations using Fourier analysis. CO-4: Compute and apply Duhamel's integral to determine the response of SDOF systems to unit impulse, arbitrary loading, step and ramp forces, pulse loadings, ground motion, and evaluate the concept of transmissibility. CO-5: Apply the principles of MDOF systems to analyze, free vibrations of shear buildings, including determining fundamental frequencies and mode shapes, employing various methods such as Stodalla-Vinaello, Modified Reyleigh's method, Holzer's method, Holzer Myklested method, and matrix method. Additionally, analyze forced vibrations of shear buildings, response to ground motion, and perform non-linear analysis using Wilson-Theta method. Furthermore, apply the concepts of continuous systems to analyze free transverse vibrations of beams for various boundary conditions and perform free vibration analysis of a cantilever beam using Rayleigh Ritz and Finite Element Method.
2	SE-613	Design of Concrete Structures	CO-1: Demonstrate an understanding of limit state design concepts in flexure, shear, torsion, and combined stresses, and apply them to the design of beams and frames. CO-2: Design slender columns and walls by evaluating effective length, determining stability indices, and analyzing unbraced and braced columns subjected to combined axial and biaxial bending. CO-3: Design walls for vertical and in-plane horizontal forces by considering slenderness, applying appropriate design methods, and ensuring structural stability. CO-4: Compute and apply yield line analysis techniques to design slabs, including simply supported, flat, and ribbed slabs. Design slabs using strip method, equivalent frame method, and consider shear and opening in flat slabs, slab fixed along edges, and skew slabs. CO-5: Develop skills in analyzing grid floors using Timoshenko's plate theory, stiffness method, and equating joint deflections. Design

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			deep beams according to Indian standard codes and ACI methods, including edge beams, considering shear strength and forces acting on joints. Design beam-column joints, including corner joints and anchorage, by following the appropriate design procedure.
3	**SE-615**	**Advanced Structural Analysis**	CO-1: Demonstrate an understanding of static and kinematic indeterminacy in structural analysis and evaluate the stiffness and flexibility of prismatic and non-prismatic members using stiffness and flexibility matrices. CO-2: Determine coordinate transformations and apply them to convert member properties and forces to the global system. Assemble global matrices including the stiffness matrix, load matrix, and consider boundary conditions and solution techniques. Compute geometric stiffness matrices for 2D truss elements and apply non-linear solution algorithms such as the iterative method and incremental method. Evaluate convergence criteria for achieving accurate results in non-linear analysis. CO-3: Develop and compute stiffness matrices for continuous beams, accounting for internal hinges, hinged and guided-fixed end supports, and shear deformations. Compute beam element stiffness, consider moment releases, and apply force transformation matrices and element flexibility matrices. Apply solution techniques for analyzing 3D truss and beam elements. CO-4: Apply the stiffness method for grids, including the determination of torsional stiffness for grid elements, understanding the advantages of torsion release, analyzing grids using conventional stiffness method and reduced stiffness method. Compute stiffness matrices for plane and space truss elements, formulate joint equilibrium equations, and calculate member forces using transformation matrices for 3D truss elements. CO-5: Demonstrate the concepts of plastic analysis and mechanism, perform non-linear stiffness matrix analysis using iterative and incremental methods. Understand hysteresis loops and make assumptions for the analysis. Modify the structural stiffness matrix, determine incremental displacement and load vectors, and apply step-by-step incremental analysis methods.
4	**SE-711**	**Advanced Concrete Technology**	CO-1: Demonstrate an understanding of concrete as a composite material, including its rheological properties, microstructure, and techniques for measuring porosity. Evaluate the influence of industrial waste on the physical, mechanical, and durability properties of concrete. CO-2: Evaluate the mechanisms of reinforcement corrosion in concrete, understand the electrochemical processes involved, and analyze techniques for corrosion monitoring. Determine and apply corrosion protection measures, including the application of coatings on rebar and the use of corrosion inhibitors in concrete. CO-3: Design and develop fibre reinforced concrete by understanding the mechanism of fibre reinforcement, different types of fibres, and their properties. Evaluate the impact of fiber

Head
Department of
Civil Engineering
Mewar University
Chittorgarh (Raj.)

			reinforcement on the performance of concrete. CO-4: Evaluate high-strength concrete, including its constituents, mix proportioning, and properties in both fresh and hardened states. Evaluate the characteristics and applications of reactive powder concrete and macro defect-free (MDF) cement. CO-5: Determine the properties and applications of self-compacting concrete, roller-compacted concrete, and ferrocement composites. Apply polymers in construction, including polymer concrete composites. Perform chemical testing of concrete and utilize non-destructive evaluation techniques, such as surface hardness, wave propagation, penetration resistance, and electrochemical and electromagnetic methods, to assess the condition of reinforced concrete structures.
5	**SE-713**	**Pre-Stressed Concrete Structure**	CO-1: Demonstrate an understanding of prestressed concrete, including the types of prestressing, systems, devices, and materials used. Evaluate the concept of losses in prestress and analyze the stresses at transfer and service loads in prestressed concrete flexural members. CO-2: Develop and design statically determinate prestressed concrete beams, considering the basic concepts of flexure and the ultimate strength in flexure. Apply code provisions from IS 1343 for the design of prestressed concrete flexural members at both ultimate and serviceability limit states. CO-3: Determine the analysis and design requirements for shear and torsion in prestressed concrete members. Apply relevant code provisions for the analysis and design of shear and torsion in prestressed concrete structures. CO-4: Evaluate the transmission of prestress in pretensioned members and determine the anchorage zone stresses for post-tensioned members. Analyze the behaviour of statically indeterminate prestressed concrete structures, including continuous beams and frames. Choose appropriate cable profiles and apply linear transformation and concordancy principles. CO-5: Design and analyze composite construction with precast prestressed concrete beams and cast-in-situ reinforced concrete slabs. Consider the effects of creep and shrinkage. Develop an understanding of partial prestressing principles and apply analysis and design concepts. Perform crack width calculations for prestressed concrete structures. Analyze and design prestressed concrete pipes, tanks, and spatial structures such as slabs, grids, folded plates, and shells. Apply design methods for composite beams, slabs, columns, and box-girders
6	**SE-715**	**Masonry structures**	CO-1: Evaluate the properties of constituents used in masonry construction, including burnt clay, concrete blocks, mortar, grout, and reinforcement. Demonstrate an understanding of masonry bonds, patterns, and the impact of shrinkage and differential movement on masonry structures.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-2: Determine the compression strength of masonry and analyze the stresses in masonry walls under various loads, including vertical loads, vertical loads with moments, eccentricity, kern distance, lateral loads in-plane, and out-of-plane. Evaluate the behaviour of masonry walls and piers under axial and flexural loads, as well as axial-shear and flexural interactions. CO-3: Determine the behaviour of unreinforced masonry buildings and recognize the importance of bands, corner reinforcement, and vertical reinforcement. Evaluate the cyclic loading and ductility of masonry walls in reinforced masonry buildings. CO-4: Demonstrate an understanding of the behaviour of masonry infills in reinforced concrete frames, including the concept of strut action. Develop structural design methods for masonry in buildings, including working stress design, ultimate strength design, seismic design, and the consideration of seismic loads. Apply code provisions and understand the role of infills, connectors, and ties in masonry structures. CO-5: Evaluate seismic evaluation and strengthening techniques for masonry buildings, including in-situ and non-destructive testing methods. Understand construction practices and new materials used in masonry construction.
7	**SE-721**	**Stability Theory and Structural analysis**	CO-1: Demonstrate an understanding of the finite deformation of structures and evaluate the elastic buckling behaviour of columns using statical, dynamical, and energy-based approaches. Analyze the effects of eccentric loading on buckling behaviour. CO-2: Evaluate the buckling behaviour of structures under nonlinear visco-elastic and elasto-plastic conditions. Analyze the flexural-torsional and lateral buckling of beams, considering imperfection sensitivity. Apply post-buckling and catastrophe theories to understand the post-critical behaviour of structures. CO-3: Determine the stability of non-conservative structures and apply nonlinear dynamical systems theory, as well as chaos theory, to analyze their behaviour. Stay updated with recent trends in the field of structural stability. CO-4: Develop a comprehensive understanding of the finite element formulation for stability analysis. Evaluate the buckling behaviour of frames, considering imperfection sensitivity and post-critical behaviour. Analyze the buckling of beams on elastic foundations, arches, and plates, including inelastic buckling phenomena. CO-5: Determine dynamic analysis of stability, including the assessment of parametric instabilities and stability under non-conservative forces. Analyze the phenomena of divergence and flutter and their impact on structural stability. Apply appropriate computational techniques to compute and analyze stability-related parameters.
8	**SE-723**	**Soil Structure Interaction**	CO-1: Demonstrate an understanding of soil-foundation interaction, including soil-structure interaction and soil-fluid-structure

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			interaction. Evaluate and interpret the idealization of soil using various linear and non-linear, isotropic and anisotropic models. Conduct experimental investigations to characterize soil parameters. CO-2: Apply finite difference methods to solve problems related to beams on linear and non-linear Winkler models. Analyze soil-structure interaction in framed structures and understand the behaviour of soil-pile interaction, particularly in the context of laterally loaded single piles. Interpret the concept of the coefficient of horizontal subgrade reaction. CO-3: Evaluate the soil-structure interaction in framed structures with pile foundations, considering the dynamic behaviour of the system. Analyze the interaction of other structures, such as tanks with annular ring foundations, chimneys, silos, cooling towers, underground subways, and tunnels, with the soil-foundation system. CO-4: Develop finite element models using appropriate software packages to analyze soil-foundation interaction problems. Apply numerical techniques to simulate and compute the behaviour of the soil-structure system. Evaluate the dynamic soil structure interaction as well as non-linear soil/concrete behaviour. CO-5: Design and determine suitable approaches for addressing the challenges posed by soil-foundation interaction in structural engineering. Apply the principles of soil-structure interaction to develop robust and safe foundation designs. Consider the impact of soil behaviour on the performance and stability of structures.
SECOND SEMESTER			
9	**SE-612**	**Advanced Design of Steel Structures**	CO-1: Demonstrate an understanding of limit state design principles for steel structures, including strength and serviceability considerations. Apply standardization and allowable stress design methods. Classify sections based on their plastic, compact, semi-compact, and slender characteristics. CO-2: Evaluate and design steel columns, considering factors such as strength, eccentricity of loading, residual stresses, and effective lengths. Analyze the behaviour of columns under torsional and torsional-flexural buckling. Apply Robertson's design curve and modifications to the design approach. Design columns using the Robertson method. CO-3: Evaluate the flexural and shear behaviour of laterally restrained beams. Analyze web buckling, crippling, and the effects of local buckling in laterally restrained beams. Consider combined bending and shear, as well as unsymmetrical bending. Understand the similarities between column buckling and lateral buckling of unrestrained beams. Analyze and design continuous beams. CO-4: Design long and short beam columns, considering stability aspects. Analyze beam-column failures based on slenderness ratio, axial force, local and overall member failure. Apply interaction formulas and design approaches for beam-columns under biaxial bending. Design beams subjected to torsion and bending, including

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			pure torsion, warping, combined bending and torsion, and lateral-torsional buckling. CO-5: Design steel connections with consideration for their complexities. Identify and apply design approaches for various types of connections, such as truss, portal frame, beam and column splice, and beam-to-beam/column connections. Evaluate the behaviour and design requirements of composite beams, composite floors, and composite columns. Analyze the characteristics and load-bearing mechanisms of shear connectors in composite structures.
10	**SE-614**	**Finite Element Method in Structural Engineering**	CO-1: Demonstrate an understanding of the basic equations of solid mechanics, including equilibrium conditions, strain displacement relations, stress strain relations, and the principle of virtual work. Apply the concept of stationary potential energy and variational formulation in solid mechanics problems. CO-2: Evaluate and apply the finite element method (FEM) for the analysis of structures. Understand the governing equations and their approximate solution methods, such as Rayleigh-Ritz, weighted residual (Galerkin), and finite difference methods. Develop displacement models using shape functions, including Lagrange and serendipity elements. Apply numerical integration techniques and analyze element properties, including isoparametric elements. CO-3: Demonstrate the analysis of framed structures using 2D and 3D truss and beam elements. Apply these elements in practical applications. Perform analysis of plane stress/strain and axisymmetric solids using triangular, quadrilateral, and isoparametric elements. Understand the concept of incompatible models in the analysis of structures. CO-4: Demonstrate three-dimensional stress analysis using isoparametric eight and twenty-noded elements. Analyze plate bending using the basic equations of thin plate theory and Reissner-Mindlin theory. Apply plate elements in practical applications. CO-5: Apply the concepts and techniques involved in finite element programming. Analyze shells using degenerated shell elements. Apply commercial finite element analysis (FEA) software to solve structural analysis problems.
11	**SE-616**	**Design of Plates and Shells**	CO-1: Demonstrate an understanding of the bending behaviour of thin plates, including the assumptions, governing differential equations, and boundary conditions in Cartesian and polar coordinate systems. Apply analytical solutions for rectangular plates using Navier and Levy's methods, considering distributed and concentrated loads. CO-2: Apply energy methods in the analysis of plates. Analyze circular plates, including the governing differential equations in the polar coordinate system. Study the behaviour of annular plates and rotationally symmetric loading. Analyze the effect of eccentric concentrated loads and simultaneous bending and stretching of thin plates.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Ra

			CO-3: Evaluate the influence of shear deformation on the bending behaviour of thin plates. Demonstrate shear deformation theories for plates, including the first-order shear deformation plate theory and higher-order shear deformation plate theory. CO-4: Apply bending analysis of laminated composite plates. Establish the strain displacement relations and governing differential equation of equilibrium for laminated composite plates. Analyze symmetric and anti-symmetric laminated plates, considering various lamination configurations. Study the cylindrical bending of laminated plates. CO-5: Design cylindrical shells and HP shells. Analyze folded plates, diaphragms, and reinforcements for shells. Understand the framework for shells and folded plates. Gain knowledge of shells, including their geometry, classifications, and stress resultants. Apply membrane theory to shells of surfaces of revolution, including cylindrical shells. Analyze the bending behaviour of singly curved and doubly curved shells using the general theory.
12	**SE-712**	**Reliability based structural design**	CO-1: Demonstrate an understanding of the concepts of structural safety, including the basic principles of statistics and probability. Apply this knowledge to analyze resistance parameters and distributions in structural design. CO-2: Design and compute probabilistic analysis of loads, including live loads and wind loads, to determine the reliability of structural systems. Utilize Monte Carlo simulation techniques to study structural safety and evaluate the level of reliability. CO-3: Apply Level 2 reliability methods, including advanced techniques, to assess the safety of structural components. Use reliability-based design approaches to determine partial safety factors and calibrate design codes. CO-4: Evaluate the reliability of structural systems, such as steel and concrete structures, offshore structures, and other applications. Apply reliability analysis techniques to assess the safety and performance of these systems. CO-5: Develop the ability to compute and apply probabilistic methods in structural engineering. Use these methods to design structures with enhanced safety and reliability, taking into account various uncertainties and risk factors.
13	**SE-714**	**Design of Tall Building**	CO-1: Determine the reasons for constructing tall buildings and analyze the structural systems and concepts used in their design. Evaluate the design criteria specific to tall buildings and apply matrix and approximate methods for their structural analysis. CO-2: Evaluate and apply the appropriate loading considerations for tall buildings, including wind, gravity, and earthquake loads. Determine the combination of loading for different design scenarios and analyze the structure using both limit state and working stress design approaches.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh

			CO-3: Demonstrate an understanding of the interaction between frames and shear walls in tall buildings. Analyze the torsional behaviour of frames and the coupled shear walls, considering the effects of openings and large panel construction. CO-4: Design the foundation of tall buildings, considering the interaction between the foundation and superstructure. Evaluate the effects of earthquakes on tall buildings and design for ductility to enhance structural performance. CO-5: Develop the ability to compute and apply the necessary analysis and design techniques for tall buildings. Apply the knowledge gained to design tall buildings that meet the requirements of safety, functionality, and structural integrity.
14	SE-726	**Advanced Numerical Methods**	CO-1: Demonstrate a fundamental understanding of programming concepts and apply them to develop algorithms for various engineering problems. Evaluate interpolation and extrapolation techniques for estimating values within and beyond a given dataset. CO-2: Determine and apply numerical integration methods such as the central difference method, the Houbolt method, Newmark's method, and the Wilson-θ method for approximating definite integrals. Compute numerical solutions using the Newton-Gauss Quadrature method. CO-3: Develop the ability to solve linear algebraic equations using methods such as Gauss elimination, Cholesky, Gauss-Cholesky, Given's, and Householder methods. Evaluate the accuracy and errors associated with these solutions. CO-4: Apply numerical methods, including the Newton-Raphson scheme and BFGS methods, to solve non-linear equations. Introduce line search algorithms to improve convergence and accuracy. CO-5: Apply eigen value problem-solving techniques such as Jacobi, QR Method, LR Method, Determinant search method, Subspace Iteration, Householder, and Given's algorithms. Develop the ability to compute and determine eigen values and eigenvectors for various engineering applications
THIRD SEMESTER			
15	SE-621	**Earthquake Analysis and Design**	CO-1: Demonstrate an understanding of the basic terms and concepts of seismology, including seismic waves, earthquake magnitude and intensity, ground motion, and earthquake-related phenomena. Apply this knowledge to evaluate and determine seismic hazards. CO-2: Evaluate and analyze the dynamic response of structures under seismic loads. Apply the principles of normalized response spectra, response spectrum analysis, and seismic coefficients to assess the behaviour of structures subjected to earthquakes. CO-3: Design structures with consideration for seismic forces, including the use of rigid diaphragms, torsional effects, lateral load distribution, moment resisting frames, and shear walls. Develop the

			ability to compute and apply lateral stiffness of shear walls and understand their interaction with frame systems. CO-4: Apply seismic design philosophy and principles, including the concepts of ductility, hysteric response, energy dissipation, and response modifications factor. Design structures based on the seismic design spectrum, considering capacity design and appropriate classification of structural systems. Interpret and apply relevant IS codal provisions for seismic design of structures. CO-5: Design multi-storeyed buildings for seismic loads, considering design criteria, P-Δ effects, storey drift, and examples of ductile detailing for reinforced concrete structures. Analyze the seismic design of elevated liquid storage tanks, including hydrodynamic pressure considerations. Evaluate and apply codal provisions for seismic design of bridges, dams, and submersible structures. Learn from case histories and develop an understanding of seismic retrofitting and strengthening procedures. Assess liquefaction potential and propose measures to reduce liquefaction hazards.
16	**SE-623**	**Design of Bridges**	CO-1: Evaluate and determine the types of bridges and their structural configurations. Apply bridge loading standards and guidelines, such as IRC, IRS, and AASHTO, to analyze and design bridge decks. Demonstrate an understanding of the impact effect and standard specifications for road and railway bridges. CO-2: Design reinforced concrete bridges, including deck slabs and T-beam bridges. Develop the ability to design balanced cantilever bridges, articulate connections, bearings, and connections. Determine the design considerations for long-span bridges. CO-3: Apply prestressed concrete principles to design pretensioned and post-tensioned concrete bridges. Analyze bridge sections for flexure, shear, and bond. Evaluate and determine the losses in prestress and deflection of girders. Design and analyze anchorage blocks and box girder bridges. CO-4: Design steel bridges and steel-concrete composite constructions. Compute and design shear connectors. Evaluate and select appropriate types of bearings and their layout for steel bridges. CO-5: Design abutments, piers, and foundations for bridges. Analyze and determine stresses in bridge components. Introduce the concept of soil-structure interaction in bridge design. Apply numerical modeling and analysis techniques. Demonstrate an understanding of earthquake-resistant design principles for bridges. Evaluate and assess existing bridges for maintenance and structural performance.
17	**SE-625**	**Seminar**	CO 1: Demonstrate effective communication skills through the delivery of a seminar presentation on a specific topic related to structural engineering. CO2: Evaluate and analyze research literature and technical information relevant to the chosen seminar topic.

Head
Department of
Civil Engineering
Mewar University
Chittorgarh (Raj.)

			CO-3: Determine the key objectives and scope of the seminar, outlining the main points to be covered and ensuring coherence and clarity in the presentation. CO-4: Design and develop visual aids, such as slides or handouts, to enhance the understanding and engagement of the audience during the seminar. CO-5: Apply critical thinking and problem-solving skills to address questions and challenges raised by the audience during the seminar, fostering a constructive and interactive discussion
18	**SE-627**	**Minor Project**	CO-1: Determine the objectives and scope of the minor project, identifying the specific problem or research question to be addressed in the field of structural engineering. CO-2: Evaluate and analyze relevant literature, research findings, and existing methodologies to inform the design and implementation of the minor project. CO-3: Develop a comprehensive project plan, including a timeline, budget, and resources required for successful execution of the project. CO-4: Design and develop innovative solutions or methodologies to address the identified problem or research question, applying appropriate structural engineering principles and techniques. CO-5: Demonstrate technical competence and skills in implementing and executing the minor project, including data collection, analysis, computation, and interpretation of results, to draw meaningful conclusions and recommendations.
FOURTH SEMESTER			
19	**SE-628**	**Dissertation**	CO-1: Determine a research topic and research question for the dissertation in the field of structural engineering, demonstrating a deep understanding of the subject matter. CO-2: Evaluate and critically analyze existing literature, research, and methodologies relevant to the chosen research topic, identifying gaps or areas for further investigation. CO-3: Design and develop a robust research methodology, including data collection, analysis, and computational techniques, to address the research question and achieve the objectives of the dissertation. CO-4: Develop and demonstrate advanced problem-solving skills by applying appropriate structural engineering principles and techniques to investigate the research question, and to derive accurate and meaningful conclusions from the collected data. CO-5: Compute and analyze research findings, interpret the results, and present them effectively in the form of a comprehensive dissertation report, applying scientific writing and communication skills, and making original contributions to the field of structural engineering.

Mewar University
Knowledge to Wisdom

Mewar university
Faculty of Engineering

Program me Outcomes of Master of Technology (Structural Engineering)

PO-1 Advanced knowledge of structural engineering: Students should have advanced knowledge of structural engineering principles, concepts, and theories, including their application in the design and analysis of structures.

PO-2 Proficiency in structural analysis and design software: Students should be proficient in the use of software for structural analysis and design, including finite element analysis software.

PO-3 Design of complex structures: Students should be able to design complex structures such as tall buildings, bridges, and industrial structures, considering the factors such as material properties, structural integrity, and environmental impacts.

PO-4 Knowledge of advanced materials: Students should have knowledge of advanced materials such as composites and alloys, and their application in the design of structures.

PO-5 Understanding of seismic and wind effects: Students should understand the effects of seismic and wind loads on structures and be able to design structures that can withstand these loads.

PO-6 Ability to conduct research: Students should be able to conduct research in the field of structural engineering, including the ability to formulate research problems, collect and analyze data, and communicate research findings.

PO-7 Ethical and professional behavior: Students should adhere to ethical and professional standards in their work, and be able to make decisions that are in the best interest of the public.

PO-8 Advanced knowledge and skills Master of Technology (Structural Engineering) are designed to develop advanced knowledge and skills in the field of structural engineering, along with the ability to conduct research and communicate technical information effectively. Graduates of this program should be well-prepared for careers in the design and analysis of complex structures, as well as for further study and research in the field.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Programme Specific Outcomes (PSO's) of Master of Technology (Structural Engineering)

PSO1: Able to design and analyze complex structural systems using advanced tools and techniques.

PSO2: Able to use software for structural analysis such as finite element analysis (FEA), numerical modeling, and simulation.

PSO3: Able to understand of different codes and standards related to structural engineering such as American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), and American Institute of Steel Construction (AISC).

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar University

Knowledge to Wisdom

Course Outcomes, Programme Outcomes & Programme Specific Outcomes
of
Master of Technology
Construction Technology & Management

Course Outcomes of Master of Technology (Construction Technology and Management)

S.NO	Course Code	Course Title	Course Outcomes
FIRST SEMESTER			
1	CTM -611	Infrastructure Planning & Contract Management	CO-1: Demonstrate a comprehensive understanding of infrastructure planning principles, including the definition of infrastructure, the steps involved in planning and appraisal of major infrastructure projects, and the use of life cycle analysis and multi-criteria analysis for comparing infrastructure alternatives. CO-2: Evaluate and critically analyze economic concepts and methodologies for economic analysis of public works, including the principles of economic analysis, social welfare function, demand curves, benefit-cost ratio, internal rate of return, ahd accounting for risk and uncertainty. CO-3: Determine and apply financial evaluation techniques in infrastructure planning, including understanding the time value of money, investment criteria, project cash flows, financial estimates and projections, cost of capital, rate of return, and project risk analysis. CO-4: Design and apply legal principles and regulations relevant to construction projects, including an understanding of public law, government departments, local authorities, private law, contracts, property law, and building law. CO-5: Develop an understanding of construction contracts and procurement strategies, including contract specifications, types of contract documents, contract procurement methods, BOT and BOOT projects, EPC contracts, price adjustment formulas, and practical implications of civil engineering and building formulae.
2	CTM -612	Project Management in Construction	CO-1: Demonstrate a comprehensive understanding of project management processes, including initiating, planning, executing, controlling, and closing processes, and apply them effectively in managing construction projects. CO-2: Evaluate and apply project integration management principles, including project plan development, project plan execution, and overall change control, to ensure successful project integration and alignment with organizational objectives. CO-3: Determine and apply project scope

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			management techniques, such as scope initiation, scope planning, scope definition, scope verification, and scope change control, to effectively define and manage project deliverables and boundaries. CO-4: Design and apply project time management strategies, including activity definition, activity sequencing, activity duration estimation, schedule development and analysis, and schedule control, using techniques such as critical path method (CPM) and program evaluation and review technique (PERT), to effectively manage project schedules and resources. CO-5: Develop and apply project cost management techniques, including resource planning, cost estimating, cost budgeting, and cost control using the earned value method, to ensure effective financial management and control throughout the project lifecycle.
3	**CTM -613**	**Construction Methods & Equipment Management**	CO-1: Demonstrate a comprehensive understanding of the planning process for equipment and methods in construction projects, including the evaluation of costs of owning and operating construction equipment, and the calculation methods for ownership and operating costs. CO-2: Evaluate and apply engineering fundamentals related to the life and replacement procedures of construction equipment, considering factors such as physical life, profit life, economic life, and conducting replacement analysis. CO-3: Determine and select appropriate earthmoving, excavating, lifting, and concreting equipment for construction projects, including bulldozers, loaders, scrapers, trucks, excavators, shovels, cranes, forklifts, pile-driving equipment, and concreting equipment, based on project requirements and specifications. CO-4: Design and optimize construction equipment systems, such as asphalt mix production and placement, by understanding the functioning of asphalt plants, paving equipment, and estimation techniques for optimizing productivity, hauling systems, and loading facilities. CO-5: Develop and apply mathematical models, simulations, and scheduling methods for estimating equipment productivity, scheduling equipment-intensive projects (horizontal and vertical), and making equipment financing decisions, considering factors such as financing methods, rental and lease

			contract considerations, and equipment resource packages.
4	CTM -614	Urban Transportation Systems Planning	CO-1: Demonstrate a comprehensive understanding of transportation planning principles, including the systems approach, various types of models, and the concept of travel demand and supply. CO-2: Evaluate and analyze the socio-economic, land use, network, and transport system characteristics that influence transportation planning, and apply appropriate data collection techniques and sampling methods for study area definition. CO-3: Determine and apply the four-stage sequential modeling approach in transportation planning, including trip generation, trip distribution, modal split, and trip assignment, and understand the integration of different modes and travel demand management measures. CO-4: Design and plan public transportation systems and transport facilities, considering technology advancements, parking facilities, pedestrian facilities, cycle tracks, bus facilities, transit planning, transit demand, and transit route networks, to optimize efficiency and accessibility. CO-5: Apply logistics concepts in transportation planning, including decision-making areas, logistics service providers, legislations, policies, emerging issues, benchmarking, reverse logistics, city logistics, ITS application, e-logistics, and the determinants of freight demand, distribution channels, and distribution costs, to optimize the logistics aspects of transportation systems.
5	CTM -616	Maintenance & Rehabilitation of Structures	CO-1: Demonstrate a comprehensive understanding of maintenance, repair, and rehabilitation practices in structural engineering, including the importance of maintenance, various aspects of inspection, damage assessment, and evaluation models, and the causes of deterioration. CO-2: Evaluate and analyze the quality assurance aspects of concrete construction, including concrete properties such as strength, permeability, thermal properties, and cracking, and understand the effects of climate, temperature, chemicals, corrosion, and design and construction errors on concrete durability. CO-3: Determine and apply knowledge of special concretes, mortars, and repair materials, including expansive cement, polymer concrete, sulphur infiltrated concrete, ferrocement, fibre-reinforced

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			concrete, rust eliminators, polymers coatings, and various repair techniques such as epoxy injection, shoring, underpinning, and corrosion protection methods. CO-4: Design and develop repair strategies for addressing specific structural issues such as low member strength, deflection, cracking, chemical disruption, weathering corrosion, wear, fire, leakage, and marine exposure, and apply engineered demolition techniques for dilapidated structures through case studies. CO-5: Apply testing methods and non-destructive testing (NDT) techniques, such as core sampling, to assess damage in concrete and steel structures, understand the need for rehabilitation, and evaluate different rehabilitation methods, including repair and maintenance of buildings and seismic strengthening techniques.
6	**CTM -617**	**Solid & Hazardous Waste Management**	CO-1: Demonstrate a comprehensive understanding of solid waste management, including the origin, characteristics, quantity, and analysis of solid waste, and the effects of solid waste on the environment. Apply appropriate techniques for the storage, collection, and transportation of solid waste. CO-2: Evaluate and analyze solid waste transformation processes and product recovery techniques, with a focus on sanitary landfills. Understand the legislation related to solid waste management and hazardous waste, including their definition, generation, classification, and the magnitude of the problem. Conduct risk assessments for hazardous waste. CO-3: Determine and apply knowledge of environmental legislation relevant to solid waste management. Conduct characterization and site assessments for waste management. Develop strategies for waste minimization and resource recovery. Understand the storage and transportation requirements for hazardous wastes. CO-4: Design and assess the hazards associated with processing and treatment of solid and hazardous wastes, considering physical, chemical, thermal, and biological processes. Develop appropriate disposal methods for hazardous wastes, including considerations for containment and remedial alternatives. CO-5: Apply principles of landfill disposal and land storage, considering the potential for ground water

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			contamination. Develop and implement strategies for containment and remediation of contaminated sites, considering the environmental impact and remedial alternatives.
SECOND SEMESTER			
7	**CTM -621**	**Infrastructural Economics & Finance**	CO-1: Demonstrate a comprehensive understanding of construction accounting principles, including the preparation and analysis of income statements, depreciation and amortization calculations, and the application of engineering economics in construction projects. Perform benefit-cost analysis and replacement analysis for decision-making. CO-2: Evaluate and analyze break-even analysis, risks, uncertainties, and their impact on management decisions in capital budgeting. Assess the effects of taxation and inflation on construction projects. Apply work pricing techniques and understand the process of contract bidding, award, revision, escalation, and turnkey activities. Conduct project appraisal and analyze project yields. CO-3: Determine and apply effective working capital management strategies in construction projects. Understand the fundamentals of international finance and its implications in the construction industry. Develop budgeting and budgetary control techniques and conduct performance appraisals for construction projects. CO-4: Design and implement strategic management concepts in construction organizations, including strategy formation and implementation, external and internal environment analysis, and the formulation of financial strategies. Evaluate the impact of strategic decisions on construction projects. CO-5: Apply decision and analytical tools in construction management, including the analysis of corporate strategic events and their implications. Understand the role of leadership in decision-making and the concept of corporate social responsibility in the construction industry.
8	**CTM -622**	**Corporate Law & Arbitration**	CO-1: Demonstrate a comprehensive understanding of the Indian Contract Act, 1872, including the definition and essentials of a contract, the formation of a valid contract, and the discharge of a contract by performance. Evaluate the concepts of offer and acceptance, consideration, capacity to contract, free consent, legality of object, and the remedies for breach of contract. Apply the principles of quasi contracts and understand special contracts such as indemnity, guarantee, bailment, pledge, and agency.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-2: Evaluate the provisions of the Companies Act, 1956, including the nature and definition of a company, registration, incorporation, and the requirements of the memorandum and articles of association. Assess the roles and responsibilities of directors, understand the process of meetings, and explore the concept of winding up. CO-3: Determine the challenges involved in managing people in the construction industry. Analyze organization and management theories, HRM theories, and strategic and operational HRM approaches. Evaluate employee relations, empowerment, diversity, work-life balance, employee welfare, and strategic human resource development. CO-4: Apply the provisions of the Information Technology Act, 2000, including the definition of electronic records, digital signatures, and electronic governance. Evaluate the regulation of certifying authorities, digital signature certificates, and the duties of subscribers. CO-5: Analyze the Right to Information Act, 2005, including the right to know and the obligations of public authorities. Evaluate the provisions related to public information officers, requests for obtaining information, exemptions from disclosure, and the powers of information commissions. Understand the penalties, jurisdiction of courts, and the process of partial disclosure of information.
9	**CTM -623**	**Quality & Safety Management in Construction**	CO-1: Demonstrate a comprehensive understanding of quality management principles and the importance of quality in the construction industry. Evaluate the different aspects of quality transition, including quality control, inspection, quality assurance, and total quality management. Analyze the evolution of quality management practices over time. CO-2: Evaluate the planning and control of quality during the design of structures. Apply various tools and techniques for quality management in construction. Assess the inspection processes for materials and machinery to ensure quality standards are met. CO-3: Determine the concepts and practices of quality assurance in construction. Evaluate the implementation of systems quality management and the use of quality standards and codes, such as ISO: 9000, in design and construction.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-4: Design and develop a comprehensive understanding of total quality management (TQM) principles, tools, and techniques. Apply TQM practices to improve quality in construction projects. Introduce the concept of safety in construction, including safety and health programs, planning for safety provisions, and analysis of construction hazards and accidents. CO-5: Apply construction safety guidelines and prevention techniques to mitigate construction hazards and prevent accidents. Analyze site management practices to ensure safety recommendations are followed.
10	**CTM -624**	**Modern Construction Techniques**	CO-1: Demonstrate a comprehensive understanding of mix design principles and their application in reinforced and prestressed concrete construction. Evaluate the use of prefabricated structures and their benefits in construction projects. Apply production techniques to achieve high-quality ready mixed concrete. Analyze productivity factors and their impact on construction efficiency. CO-2: Evaluate and compare construction techniques related to steel and reinforced concrete framing, including floor systems, roof systems, masonry construction, curtain walls, and building insulation. Assess the selection and application of interior and exterior finishes in construction projects. CO-3: Determine appropriate formwork design principles for concrete construction. Apply construction techniques suitable for high-rise buildings and fire-resistant structures. Evaluate the advantages and challenges associated with fire-resistant construction techniques. CO-4: Design and develop cost-effective construction techniques (CECT) for optimizing project budgets and resources. Assess repair techniques and innovative construction methods for improving structural integrity and longevity. Evaluate the benefits and challenges of prefabrication, pre-casting, modular construction, in-situ pre-fabrication, lift slab, and tilt-up construction. CO-5: Apply case studies to analyze and implement construction techniques in the housing sector. Evaluate non-destructive testing methods for quality control and structural assessment. Assess the characteristics and applications of modern construction materials and smart materials in the context of construction technology and management.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

11	CTM -626	**Principles of affordable Housing**	CO-1: Demonstrate a comprehensive understanding of affordable housing, including an introduction to the topic, current trends, and an overview of affordable housing development process. Evaluate project feasibility and assess the policy, practice, and issues related to affordable housing. CO-2: Evaluate the financing options for affordable housing projects and apply site planning principles to the development of affordable housing. Analyze the architectural aspects and cost considerations of new and rehabilitated affordable housing. Assess the role of non-profit organizations in housing development and explore future trends in affordable housing production. CO-3: Determine the potential of alternative building materials for low-cost housing, including an introduction to the concept and the use of substitutes for scarce materials. Evaluate the utilization of industrial and agricultural waste as alternative building materials. Develop strategies for promoting the adoption of alternative building materials. CO-4: Evaluate the provision of low-cost infrastructural services for affordable housing, including sanitation, domestic waste disposal, water supply, and energy solutions. Assess the present scenario and explore approaches to ensure cost-effective and sustainable infrastructure for affordable housing projects. CO-5: Apply approaches and strategies for housing the urban poor, including the adoption of innovative and cost-effective construction technology. Design and develop solutions that address the unique challenges and requirements of housing the urban poor.
12	CTM -627	**Building Services & Maintenance Management**	CO-1: Demonstrate a comprehensive understanding of building orientation and planning, including grouping and circulation principles, lighting and ventilation considerations, termite proofing, lightning protection, and fire protection strategies. Evaluate the impact of these factors on building design and construction. CO-2: Evaluate the use of prefabrication systems in residential buildings, including planning, module sizes, and component selection. Analyze the application of shell structures, domes, folded plate structures, skeletal structures, and space frame structures in building construction.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-3: Determine the design and construction requirements of grain storage structures, earthquake-resistant structures, air-conditioning and heating systems, and acoustics and sound insulation. Evaluate plumbing services in building design and construction. CO-4: Design and analyze formwork and false work systems, considering construction planning and site constraints. Evaluate different types of formwork, including common, special, and proprietary forms. Compute concrete pressure on forms and analyze the effects of wind load, foundation, and soil on false work design. Apply safety measures in formwork and false work usage. CO-5: Design functional building layouts, optimizing space utilization through spatial synthesis and graphical techniques. Determine space requirements and relationships for various building types such as residential, offices, hospitals, etc. Evaluate engineering services systems in buildings, including lifts, escalators, cold and hot water systems, wastewater systems, and electrical systems. Develop maintenance plans and standards, utilize management information systems (MIS), and make economic maintenance decisions for building upkeep.
THIRD SEMESTER			
13	**CTM -631**	**Construction Information System**	CO-1: Demonstrate an understanding of management information systems in the construction industry, including their role, components, and integration with computer-aided design (CAD). Evaluate the current trends and advancements in integrating technology for effective data management. CO-2: Evaluate computerized project management systems and their application in planning, scheduling, estimating, and controlling construction projects. Utilize automated programs to process data and perform pricing tasks in construction. CO-3: Determine the use of tendering, scheduling, and cost control systems in construction. Apply simulation techniques for analyzing and optimizing construction operations. Utilize internet technology and web applications for construction management, including the use of project planner software. CO-4: Apply integrated construction management information systems, specifically focusing on project management information systems and their integration with functional areas such as finance,

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			marketing, production, and personnel. Compare decision support systems (DSS), executive information systems (EIS), and expert systems (ES) in construction management. CO-5: Apply systems methodology and consider knowledge and human dimensions in software development and implementation. Implement and control information systems in construction, including testing security, coding techniques, error detection, validation, and cost-benefit analysis. Assess the value and risk of information systems. Conduct system audits and evaluate software engineering qualities, software life cycle models, verification and validation processes, and software quality assurance.
14	**CTM -632**	**Sustainable Design & Value Analysis**	CO-1: Demonstrate an understanding of sustainability principles in construction, including the challenges faced in achieving sustainable construction practices. Evaluate the impact of design, construction, equipment, materials, and systems on sustainability. Determine strategies for maintenance, conservation, and waste management in sustainable construction. CO-2: Evaluate energy-efficient building practices and their contribution to green and sustainable buildings. Analyze concepts such as natural lighting, rainwater harvesting, solar panels, and solar HVAC systems. Assess the rating systems and delivery methods for green buildings. CO-3: Design sustainable buildings considering economic, environmental, and social factors. Apply sustainable building design principles and techniques. Apply rating systems to evaluate the sustainability of buildings. CO-4: Apply advanced conceptual estimating techniques and quick methods for determining approximate project costs. Conduct cost-benefit analysis and economic performance analysis for construction projects. Utilize incremental analysis and economic feasibility analysis to evaluate the financial viability of projects. CO-5: Apply techniques of economic evaluation to assess the overall economic feasibility of projects. Analyze case studies to understand the practical application of life cycle cost analysis in construction. Perform life cycle cost analysis for construction projects, considering the costs of initial investments, replacements, operations, maintenance, and repair investments.

Head
Department of
Civil Engineering
Chittorgarh (Raj.)

15	CTM-633	Seminar	CO-1: Demonstrate a deep understanding of a specific research topic or emerging trend in construction technology and management, and effectively communicate it through a seminar presentation. CO-2: Evaluate and critically analyze the latest developments, advancements, and challenges in the field of construction technology and management, and assess their implications for the industry. CO-3: Determine and identify key research gaps or areas of improvement within the domain of construction technology and management, and propose potential research questions or directions for further investigation. CO-4: Design and develop a comprehensive seminar proposal, outlining the objectives, methodology, and expected outcomes of the research or study to be presented, and incorporate feedback to refine the proposal. CO-5: Apply research methodologies and computational tools to gather, compute, and analyze relevant data or information related to the chosen seminar topic, and present findings and conclusions in a clear and organized manner.
16	CTM-634	Minor Project	CO-1: Demonstrate the ability to identify and analyze a specific problem or challenge in the field of construction technology and management, and propose appropriate solutions. CO-2: Evaluate and critically assess existing construction processes, techniques, or technologies, and determine areas of improvement or innovation to enhance project efficiency, sustainability, and quality. CO-3: Design and develop a feasible and comprehensive plan for implementing a minor construction project, considering factors such as project scope, resource allocation, risk management, and regulatory compliance. CO-4: Compute and analyze relevant data and metrics related to the minor construction project, using appropriate software tools and techniques, to make informed decisions and optimize project outcomes. CO-5: Apply project management principles and techniques to effectively manage and execute the minor construction project, ensuring coordination

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			among team members, adherence to timelines and budgets, and achievement of project objectives.
FOURTH SEMESTER			
17	**CTM-641**	**Dissertation**	CO-1: Demonstrate a comprehensive understanding of advanced construction techniques and project management principles, and their application in real-world scenarios. CO-2: Evaluate the effectiveness of various construction materials, methods, and technologies, and determine their suitability for different construction projects based on performance, cost, and sustainability. CO-3: Design innovative construction strategies and develop sustainable solutions for enhancing project productivity, safety, and quality, while considering environmental and social factors. CO-4: Compute and analyze complex construction-related data using advanced software tools and techniques, and utilize the findings to make informed decisions for optimizing construction processes and resource utilization. CO-5: Apply effective project management techniques and leadership skills to successfully plan, execute, and monitor construction projects, while addressing challenges and ensuring adherence to timelines, budgets, and quality standards

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar university
Faculty of Engineering

Programme Outcomes of Master of Technology (Construction Technology& Management)

PO-1 Problem analysis: Ability to apply the principles of construction technology and management to solve complex problems in the construction industry.

PO-2 Advanced knowledge: Knowledge of advanced construction materials, methods, and techniques.

PO-3 Project management and finance: Understanding of project planning and scheduling, and the ability to develop construction schedules and monitor project progress Knowledge of cost estimation and budgeting techniques, and the ability to prepare and manage project budgets..

PO-4 Multidisciplinary Approach: Work effectively in multidisciplinary teams to solve complex environmental engineering problems.

PO-5 Ability to manage construction contracts, including the development and administration of contracts and the resolution of contract disputes.

PO-6 Design/ development of solutions: Knowledge of safety and health regulations and practices in the construction industry, and the ability to implement and enforce them.

PO-7 Research Ability to conduct research and use data analysis techniques to make informed decisions related to construction projects.

PO-8 Ethics Understanding of ethical principles and professional standards in the construction industry, and the ability to apply them in practice.

Mewar University
Knowledge to Wisdom

Programme Specific Outcomes (PSO's) of Master of Technology (Construction Technology& Management)

PSO1: Able to demonstrate an understanding of the principles and techniques used in construction project management, including scheduling, cost estimation, risk management, and quality control, including construction technology, building systems, and building codes.

PSO2: Able to read and interpret construction plans and specifications to determine project requirements and to ensure compliance with building codes, regulations, and standards.

PSO3: Able to manage construction teams and communicate with stakeholders, including clients, architects, engineers, and contractors.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar University

Knowledge to Wisdom

Course Outcomes, Programme Outcomes & Programme Specific Outcomes
of
Master of Technology
Transportation Engineering

Outcomes of Master of Technology (Transportation Engineering)

S.NO	Course Code	Course Title	Course Outcomes
FIRST SEMESTER			
1	CTR -411	Traffic Engineering	CO-1: Demonstrate an understanding of traffic characteristics, road user characteristics, and vehicular characteristics that influence road design and traffic flow. CO-2: Evaluate and apply appropriate data collection techniques for traffic studies, including classified traffic volume, spot speed, speed and delay, origin and destination, and parking studies. CO-3: Determine and compute sampling techniques, sample size, and accuracy in traffic studies, and apply sampling theory to interpret and analyze traffic data effectively. CO-4: Design and develop "before and after studies" to economically evaluate the effectiveness of improvement measures in traffic management, considering various factors such as traffic flow, speed, and capacity. CO-5: Apply traffic flow theory and simulation techniques to analyze traffic flow variables, identify bottlenecks, and assess delays at intersections. Design and evaluate traffic control devices, including traffic signs, markings, road lightings, islands, channelization, and road furniture, for improved traffic management and safety
2	CTR -412	Pavements Design and Construction Techniques	CO-1: Demonstrate an understanding of the factors influencing the design and performance of road pavements, including pavement layers, types, functions, and selection criteria. CO-2: Evaluate the impact of various factors on the design and performance of flexible and rigid pavements, such as pavement design factors, axle load distribution, subgrade support, resilient modulus, fatigue tests, and climatic, drainage, and environmental factors. CO-3: Design and develop flexible pavements by applying elastic theory to calculate stresses, deflections, and strains in single, two, and three-layer systems, and utilize empirical, semi-empirical, and theoretical approaches for pavement design. CO-4: Design rigid pavements according to genefal design principles, considering stresses due to wheel loads and temperature variations, and apply IRC

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			guidelines for the design of cement concrete pavements, including joint design and slab thickness. CO-5: Apply appropriate construction techniques and methodologies for the construction of non-bituminous pavements, such as granular roads, GSB, WBM, WMM, and cement concrete roads, including the use of relevant machinery and adherence to IRC and MORTH specifications.
3	CTR -413	Applied Statistics	CO-1: Demonstrate an understanding of linear second-order partial differential equations in two independent variables, including their normal forms and classification into hyperbolic, parabolic, and elliptic equations, and solve Cauchy problems. CO-2: Evaluate the wave equation and its solution as an initial value problem, analyze the significance of characteristic curves, and apply Laplace transform techniques to solve related problems such as displacements in a long string, a string under its weight, and vibrations of a bar with prescribed force on one end. CO-3: Design variational problems with stationary values, apply Euler's equation, and solve more general variational problems with natural boundary conditions and moving boundaries, employing isoparametric methods and techniques such as Ritz, Kantorovich, and Galerkin. CO-4: Develop an understanding of standard eigen value problems, analyze the properties of eigen values and eigenvectors, explore generalized eigen value problems, apply the Sturm sequence, and utilize transformation methods including Jacobi, Givens, and Householder transformations. CO-5: Determine appropriate iterative schemes, such as forward and inverse iteration, Graham-Schmidt deflation, simultaneous iteration, and subspace iteration, and employ algorithms like Lanczos algorithm to estimate core and time requirements in solving eigen value problems.
4	CTR -414	Project Engineering & Management	CO-1: Demonstrate an understanding of project management principles and practices, including the systems approach, systems theory, and concepts, as well as the organization and management functions involved. CO-2: Evaluate project management tools and techniques, including project management processes, organizational structures, team management, and the role of a project manager as a team leader. CO-3: Design and develop cost estimation and control

Head
Department of
Civil Engineering

			strategies in construction projects, incorporating cost optimization, resource planning, value engineering, and techniques for project selection. CO-4: Apply contract management principles and practices, including tendering and contracting, understanding laws and conditions, identifying potential problems, and implementing post-contract measures and arbitration. CO-5: Determine project scheduling and analysis methods, such as CPM, PERT, linear programming, queuing concepts, simulation, bidding models, and game theory, to effectively plan and manage transportation engineering projects.
5	**CTR -511**	**Bridge Engineering**	CO-1: Demonstrate a comprehensive understanding of the principles and practices related to the classification, investigation, and loading standards for bridges, including the ability to compute and determine appropriate actions for IRC and Railway loads. CO-2: Evaluate the impact of bridge substructures on overall bridge design, including the determination of maximum flood discharge and linear waterway, and develop appropriate design solutions based on the given parameters. CO-3: Design bridge substructures, including piers, pier caps, and well elements, considering the loads acting on them and the maximum depth of scour. Apply the appropriate design methods such as sinking of wells, Pigeaud's curves, analysis of beams using Courbon's Method, Hendry Jaeger Method, and Guyon and Massonet Method. CO-4: Develop an understanding of box girder bridges and cable bridges, including the application of grillage analogy and linear analysis of cables and towers. Apply appropriate methods to design these types of bridges based on given specifications. CO-5: Determine the functions, types, and selection of bridge bearings and expansion joints, including the design of electrometric bearings for different conditions. Apply the appropriate knowledge to select and design suitable expansion joints, considering different types and their specific applications.
6	**CTR -512**	**Advanced Structural Analysis**	CO-1: Demonstrate an understanding of the Moment Distribution method and its application to the analysis of portal frames with inclined legs, gable frames, and simple portal frames. CO-2: Evaluate the Strain Energy method and its application to the analysis of continuous beams and simple portal frames.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-3: Develop the ability to construct Influence Line diagrams for reaction, shearing force, bending moment, and member forces in determinate beams and trusses. CO-4: Compute the analysis of two-hinged and three-hinged arches using influence lines. CO-5: Apply the Flexibility Method and the Stiffness Method for structural analysis using matrix approach, and apply these methods to analyze continuous beams and plane trusses.
7	**CTR -513**	**Ground Improvement Techniques**	CO-1: Demonstrate an understanding of the need and objectives of ground improvement and the classification of ground modification techniques. CO-2: Evaluate the suitability and feasibility of different ground modification techniques based on specific project requirements. CO-3: Design and develop mechanical modification techniques for ground improvement, including methods of compaction, shallow and deep compaction techniques, and field compaction control. CO-4: Compute and apply hydraulic modification methods for ground improvement, such as dewatering techniques, pre-loading with and without sand drains, and the use of various drains for soil stabilization. CO-5: Determine the appropriate grouting techniques and control measures for different applications, including categorization of grouting, selection of grout materials, and understanding the art of grouting
8	**CTR - 415**	**CAD & Computational laboratory**	CO-1: Demonstrate proficiency in using MS Excel and Access to create data processing templates, apply standard functions, and perform statistical analysis. CO-2: Evaluate the effectiveness of macros in automating data processing tasks and improving efficiency in MS Excel and Access. CO-3: Design and develop graphical presentations of data using MS Excel, including charts, graphs, and data visualization techniques. CO-4: Compute linear regression, multiple linear regression, non-linear regression, stepwise regression, and two-stage regression analyses using mathematical and statistical packages such as MATLAB and SPSS. CO-5: Apply statistical distributions, time series analysis, and multivariate analysis techniques using MATLAB and SPSS for analyzing and interpreting transportation engineering data

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

SECOND SEMESTER			
9	CTR -421	Pavement Management System	CO-1: Demonstrate an understanding of the components and essential features of Pavement Management Systems, including the definition, levels, and functions of a PMS. CO-2: Evaluate the performance of pavements using serviceability concepts, roughness components, and various modeling techniques such as IRI, structural condition deterioration models, mechanistic and empirical models, and HDM and other models. CO-3: Design and develop evaluation methods for assessing the structural capacity of pavements, including non-destructive testing (NDT), analysis of condition surveys, distress identification, and destructive structural analysis. CO-4: Design and determine appropriate pavement alternatives and selections based on design objectives, constraints, structural response models, physical design inputs, alternate pavement strategies, economic evaluation, life cycle costing, and analysis of distress and performance. CO-5: Apply expert systems and computer-based tools to pavement management, including the role of computers in managing pavements, the application of expert systems for pavement evaluation and rehabilitation, knowledge-based expert systems, and case studies demonstrating the use of these systems
10	CTR -422	Urban Transportation Planning	CO-1: Demonstrate an understanding of the fundamental concepts and principles related to travel demand estimation and forecasting, including the travel demand function, independent variables, and assumptions. CO-2: Evaluate different data collection techniques and inventories used in transportation studies, such as roadside and home interviews, IPT surveys, sampling techniques, and the use of secondary sources for data collection. CO-3: Design and develop travel demand estimation models using the four-step travel demand forecasting approach, including trip generation analysis, zonal models, category analysis, and household models. CO-4: Compute and apply trip distribution methods, such as mode factor, gravity model, and opportunity model, for analyzing and predicting travel patterns and flows. CO-5: Determine appropriate traffic assignment techniques, including minimum path trees, all-or-

Head
Department of
Civil Engineering

			nothing assignment, capacity restraint assignment, and corridor identification, for traffic network analysis and planning. Additionally, demonstrate the ability to prepare and evaluate transportation plans, and perform deficiency analysis.
11	CTR -423	Highway Construction & Quality Control	CO-1: Demonstrate an understanding of the components of road and pavement structure, including subgrade, drainage system, functions, requirements, and sequence of construction operations. CO-2: Evaluate the drainage requirements for roads and design various components of the drainage system, including surface and subsurface drainage. Design appropriate filter materials for road drainage. CO-3: Design and develop construction plans for road projects, including the selection and use of appropriate road construction equipment such as excavators, graders, soil compactors/rollers, pavers, and other equipment for different pavement layers. CO-4: Compute and apply quality control tests for different types of granular base courses, bituminous layers, sub-base and base courses for cement concrete pavements, and interlocking concrete block pavements. Ensure adherence to specifications during construction. CO-5: Determine appropriate maintenance works for various components of road infrastructure, including day-to-day and periodic maintenance. Develop strategies to address special problems in the construction and maintenance of hill roads, including landslides, embankment and cut slope protection, and addressing surface issues such as reflection cracks and slipperiness
12	CTR -424	Remote Sensing &GPS	CO-1: Demonstrate an understanding of the basic principles of remote sensing, including the electromagnetic properties and interaction with Earth surface materials. CO-2: Evaluate recent developments in remote sensing technology and analyze their social and legal implications. CO-3: Design and develop pre-processing techniques for remotely sensed data, including geometric connection and registration, atmospheric correction, and image transforms. CO-4: Compute and apply enhancement and filtering techniques to improve the quality and interpretability of remote sensing data, such as contrast enhancement, thematic information extraction, and change detection. CO-5: Determine the application of remote sensing and

			GPS in transportation engineering, including intelligent transport systems, urban transport planning, accident studies, transport system management, and road network planning
13	**CTR -521**	**Rail Road Engineering**	CO-1: Demonstrate an understanding of the important developments in Indian Railways, the organization 'of Indian Railways, and the impact of track, loco, and traction revolution on traffic growth. CO-2: Evaluate the track standards, structure, and stresses on the track, including bending stresses in rail, stresses in sleeper and ballast, and the effect of hammer blow. Analyze the types of rails, defects in rails, rail failure, welding methods, and ultrasonic testing of thermit welding joints. CO-3: Design and develop solutions for the formation, sleeper, and ballast in railway tracks. Analyze the functions of formation, profile of banks and cuttings, track drainage, soil stabilization methods, and the different types of sleepers and ballast. Investigate point, crossing, and turnout designs and address associated problems. CO-4: Compute and apply geometric design principles to track design. Calculate the radius, degree of curve, super elevation, gradients, safe speed, cant, and transition curve. Design vertical curves and solve related problems. CO-5: Determine and apply knowledge of signal and interlocking systems in railways. Classify signal types, analyze electrical signaling systems, track circuits, and different block systems. Evaluate modern signaling techniques, including route relay interlocking and CTC systems. Assess the travel patterns, challenges, and different forms of urban transportation, including metropolitan railways and various rail systems.
14	**CTR -522**	**Airport Planning & Design**	CO-1: Demonstrate an understanding of the growth of air transport, airport organization, and associations, as well as the classifications of airports, airfield components, airport traffic zones, and approach areas. CO-2: Evaluate the factors affecting capacity and determine the runway capacity related to delay, gate capacity, and taxiway capacity, considering the characteristics of aircraft and their impact on airport design. CO-3: Design airport layouts and conduct surveys, taking into account airport site selection, runway length and width, sight distances, longitudinal and transverse grades, runway intersections, taxiways, clearances, aprons, numbering, holding apron, and noise control.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

			CO-4: Develop operational concepts and design the terminal area, considering space relationships, area requirements, and the management of vehicular traffic and parking at airports. CO-5: Determine the grading and drainage requirements of airport areas, including the grading of airport land, design of drainage systems, construction methods, and layout of surface and subsurface drainage systems, considering hydrology and drainage problems
15	**CTR -523**	**Environmental Impact Assessment**	CO-1: Demonstrate an understanding of the concept of Environmental Impact Assessment (EIA) and its objectives. CO-2: Evaluate the advantages and limitations of Environmental Impact Assessment (EIA) in analyzing environmental imbalances caused by human activities. CO-3: Design and develop appropriate indicators for assessing environmental impacts in different subsystems, including climate, terrestrial, aquatic, socio-economic, and health. CO-4: Compute and apply methodologies for assessing environmental issues in water resource development, including land use, soil erosion, flow changes, sedimentation, and water quality impacts. CO-5: Determine appropriate methodologies for carrying out Environmental Impact Assessments (EIA) in various contexts, such as industrial development, highways, mining, and energy development.
THIRD SEMESTER			
16	**CTR -431**	**Advance Modelling Techniques in Highway Engineering**	CO-1: Demonstrate an understanding of the significance of Artificial Intelligence (AI) in Transportation Engineering and its applications for solving transportation problems. CO-2: Evaluate and compare statistical methods and various AI techniques used in Transportation Engineering. CO-3: Design and develop fuzzy logic-based models for solving transportation problems, considering the merits and limitations of fuzzy logic. CO-4: Compute and apply Artificial Neural Networks (ANN) techniques, including back-propagation learning algorithm, to solve transportation engineering problems. CO-5: Determine the application of Genetic Algorithms (GA) in Transportation Engineering and develop solutions using GA principles essential criteria.

Head
Department of
Civil Engineering

17	CTR -432	GIS Application in Transportation Engineering	CO-1: Demonstrate an understanding of the fundamental concepts and components of GIS, including its use in decision making and data processing. CO-2: Evaluate different methods of data input and output in GIS, such as keyboard entry, manual digitizing, scanning, and remotely sensed data, and assess data quality components and sources of error. CO-3: Design and develop effective data management strategies for GIS, including the use of databases and spatial data models, and analyze and integrate spatial and attribute data for analysis and output formatting. CO-4: Determine the requirements for implementing a GIS system, evaluate alternative systems, justify the chosen system, and develop an implementation plan. Operate and maintain the GIS system effectively. CO-5: Apply GIS in transportation engineering by designing intelligent information systems for road accessibility studies, developing GIS databases for physical facility planning, utilizing decision support systems for land use planning, performing environmental impact assessments, designing highway alignments and road network planning, and analyzing traffic congestion and accident investigations using GIS-based approaches
18	TE –433	Seminar	CO-1: Demonstrate effective presentation and communication skills in delivering a seminar on a specific topic related to transportation engineering. CO-2: Evaluate and critically analyze relevant literature and research findings related to the chosen seminar topic in transportation engineering. CO-3: Design and develop a well-structured seminar presentation that effectively conveys key concepts, theories, and applications in the chosen topic of transportation engineering. CO-4 Compute and analyze data or case studies to support the arguments and conclusions presented in the seminar, using appropriate quantitative and qualitative methods. Apply the knowledge and principles learned in the M.Tech Transportation Engineering program to the seminar topic, demonstrating a comprehensive understanding of the subject matter. CO-5: Determine appropriate strategies and techniques for engaging the audience during the seminar, such as interactive discussions, visual aids, or multimedia presentations, to enhance understanding and knowledge retention.

Head
Department of
Civil Engineering

19	CTR –434	Minor Project	CO-1: Demonstrate the ability to identify and analyze a transportation engineering problem or research question for the minor project. Evaluate and select appropriate methodologies, tools, and techniques to address the identified transportation engineering problem or research question. CO-2: Design and develop a comprehensive project plan that outlines the objectives, scope, methodology, and timeline for the minor project. CO-3: Apply theoretical concepts, principles, and knowledge gained throughout the program to address the transportation engineering problem or research question in the minor project. CO-4: Determine and propose effective and innovative solutions, strategies, or recommendations based on the findings and analysis conducted in the minor project. CO-5: Demonstrate effective communication skills by presenting the findings, results, and recommendations of the minor project in a clear and concise manner, both orally and in writing.
FOURTH SEMESTER			
20	CTR –441	Dissertation	CO-1: Demonstrate the ability to identify and analyze a transportation engineering problem or research question for the minor project. CO-2: Evaluate and select appropriate methodologies, tools, and techniques to address the identified transportation engineering problem or research question. CO-3: Design and develop a comprehensive project plan that outlines the objectives, scope, methodology, and timeline for the minor project. CO-4: Compute and analyze relevant data and information using appropriate statistical and analytical techniques to derive meaningful conclusions and insights. CO-5: Determine and propose effective and innovative solutions, strategies, or recommendations based on the findings and analysis conducted in the minor project.

Mewar university
Faculty of Engineering

Programme Outcomes of Master of Technology (Transportation Engineering)

PO-1 Develop advanced analytical skills in transportation planning and engineering through extensive coursework and research projects.

PO-2 Apply theoretical knowledge and practical techniques to address real-world transportation challenges, such as traffic congestion, infrastructure design, and sustainable transportation systems.

PO-3 Demonstrate expertise in using state-of-the-art software and tools for transportation modeling, simulation, and analysis.

PO-4 Design and evaluate transportation systems and infrastructure to enhance efficiency, safety, and sustainability, considering factors like traffic flow, environmental impact, and economic viability.

PO-5 Conduct research and contribute to the advancement of transportation engineering knowledge by publishing research papers in reputable journals and presenting findings at conferences.

PO-6 Effectively communicate technical information and project proposals to diverse stakeholders, including government agencies, transportation companies, and the public.

PO-7 Develop leadership and teamwork skills by collaborating with multidisciplinary teams to solve transportation engineering problems and manage transportation projects effectively.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)

Mewar University
Knowledge to Wisdom

Programme Specific Outcomes (PSO's) of Master of Technology (Transportation Engineering)

PSO1: Able to plan, design, and manage transportation infrastructure, considering social, economic, and environmental factors.

PSO2: Able to adapt to emerging technologies and trends in transportation engineering and apply them to real-world situations.

Head
Department of
Civil Engineering
Mewar University, Chittorgarh (Raj.)